THE PROGRESSIVE FISH CULTURIST

NEWS AND VIEWS FROM MANY SOURCES ON PRACTICAL HATCHERY PROBLEMS

ISSUED BY THE

U. S. DEPARTMENT OF COMMERCE

HARRY L. HOPKINS, *SECRETARY*

BUREAU OF FISHERIES

CHAS. E. JACKSON, *ACTING COMMISSIONER*

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THE PROGRESSIVE FISH CULTURIST

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Memorandum I-131 Washington, D. C., March-April 1939 No. 44

REPORT ON PISGAH FISH MANAGEMENT, 1939

By William M. Keil, U. S. Forest Service, in collaboration with
Thomas K. Chamberlain and Reuben O. Knuth, U. S. Bureau of Fisheries.

THE BUILDING up and maintenance of good trout fishing in waters that are adapted to such species is, under the most economical methods of procedure, an expensive proposition. Present day anglers are not content to await the long drawn out processes of natural increase to provide them with a catchable supply.

In many of our waters in which trout once thrived and were fairly abundant, the conditions of environment have so changed in character as to make successful restocking difficult, and in many instances all but impossible. In the Pisgah National Forest, while there are no major sources of industrial pollution to make trout habitat totally unsuitable, the results of former lumbering operations and fires are still evident in their effects on the life of the waters. More recently, the construction of new roads and the widening and improvement of others, has filled the stream channels with eroding material that is, at least temporarily upsetting the fish food balance, and making the environment less desirable.

The fish management program as set up cooperatively by the Forest Service, the U. S. Bureau of Fisheries, and the North Carolina Department of Conservation and Development, was instituted primarily for the purpose of improving the fishing through a restoration to more natural conditions of the streams themselves, and systematic restocking with the species and numbers of trout best adapted to the conditions. However as the work progressed, a number of secondary objectives have been undertaken that it is hoped may be of value for application to other National Forests in the southern Appalachian Region. These are covered in the sections devoted to Aquatic Biological Investigations, and to some extent under Fish Cultural Operations.

BIOLOGICAL INVESTIGATIONS

The streams in the Pisgah National Forest have the local reputation of once having been excellent trout streams. However, there is no evidence that the fishing was ever actually intense until about the period when lumbering operations were in full swing. Whether such lumbering, which was completed some six or eight years ago, or the increased fishing was responsible, it became evident over a dozen years ago that the streams were largely depleted of trout.

The drought years of 1926 and 1927 have been given the credit by some local anglers for having wiped out the trout population of the forest, particularly in the smaller streams. Doubtless these were hard years for the trout. The timber had been newly removed opening up the streams to direct sunlight. The second growth had not grown sufficiently to hold much moisture with its roots or to provide shade. The forest has no springs, so the little water the cut-over land could furnish its streams became dangerously warm under the southern sun.

Deforestation promotes erosion, both directly, and, in this particular case with the aid of two additional factors: the forest road construction program begun in 1933, and, recently, the grazing and browsing of cattle and of a large deer population. Road construction produces loose dirt on the side of the road which readily washes into the streams. Grazing and browsing removes young growth which helps to hold down the soil. Sand and dirt washed into trout streams does considerable damage, which is direct and indirect. It is direct when the trout eggs and trout fry are smothered on their nests. It is indirect when the interstices between the stones and gravel of the stream beds become filled with sediment. In these interstices live trout fry when they leave their nests and until they are able to swim freely and look for food. With the filling of the interstices with silt or sand the trout fry are smothered or forced out into the open where they become easy prey for larger active fish. More serious even than this is the effect upon bottom organisms required by trout as food. The interstices normally are great reservoirs of these animals, some feeding on rotten leaves or other organic matter, others feeding on the plant-feeding organisms or on each other. With their normal feeding areas filled with sediment, they too are smothered or forced into the open to be largely devoured or washed away.

The forest is slowly growing back. Cattle grazing in the forest has been stopped. The excessive browsing by deer is being reduced through controlled deer hunts. Were it not for the uncertainties of future road construction with the continual erosion which always follows from this work, the prospect would be that of a slowly improving set of stream conditions. Those roads which are now under construction, nearly completed in most cases, probably have done their maximum damage to the streams. However, a segment of the Park-to-Park Highway is scheduled to be constructed immediately across the headwaters of most of the streams of the forest. This is not a pleasing prospect for those primarily interested in stream trout fishing. Loose dirt from construction work washing into the very headwaters of the forest streams will fill the interstices and the trout pools from end to end of the streams. Fortunately the Forest Service is aware of this menace, and assurance has been given of an effort to reduce such damage to a minimum by a special effort towards tying down loose soil with a covering of forest floor mulch as promptly as possible. It can only be hoped that stream conditions will not be made even worse than they are, and that the generally favorable developments already mentioned may to some extent offset the new damage.

With stream conditions being as they are, it is natural that the stream bottom studies should indicate that the streams of the Pisgah National Forest should rank medium to low in the supply of bottom organisms available as trout food. This being the situation, the danger seems to be more from overstocking the streams than from understocking. Also no heavy fishing under present conditions may be hoped for. That overstocking is a real problem has been demonstrated by actual tests in several small streams, particularly in Cove Creek a tributary of Davidson River. A full report on this stream is scheduled for next spring. Briefly it may be said here that a planting of marked brook trout averaging over six inches long was made in this stream in the fall of 1937. The condition of these fish through the winter remained excellent. By spring, however, they were in poor condition, and by late summer they evidently weighed less, on the average than when planted ten months before. Their appearance showed the usual "Pin head" condition of under nourishment. Checks showed that few had drifted down into the Davidson River, yet there was evidence that a large proportion of the planted trout had disappeared, probably becoming so weakened as to be unable to escape the many water snakes present in the stream. As stomach-content studies showed many Cove Creek trout with stomachs filled with gravel, mostly the cases of certain caddis fly larvae, and it is possible that where such practice is long continued, the trout may find the diet fatal.

Returning to a consideration of the bottom studies, it will be noted that more attention has been given the Davidson River and its tributaries than other streams. This river is easy of access over most of its length, and is the most popular with anglers. Also the cooperative rearing station stands beside its upper waters. Since this river is an excellent representative of the forest streams, it is natural that it should be chosen for concentrated attention and used to judge other streams of this and other nearby national forests. Following this discussion there are included two tables which contain sufficient of the data to give a picture of the actual trout food situation as indicated by the stream bottom sampling undertaken.

Table No. 1 lists for each month, the number and weight of bottom organisms per square foot of stream bottom for the Davidson River and its main tributaries as a whole, and for each of the larger tributaries in turn. Table No. 2 gives for each month the weight of the bottom organisms per square foot for each of the main streams which have been studied in Pisgah National Forest. Since only the data for the Davidson River and its tributaries are fairly complete, the data for the other streams are arranged so as to make as thorough a comparison as possible. These other data were taken as convenient at somewhat irregular intervals. In addition to the data given in this report, other data have been accumulated, particularly regarding dominant animal forms found in the bottom samples, chemicals, temperatures, and observations on the trout in the streams. This material will be utilized in future reports.

Considering the data, it may assist in making the figures for various months more understandable, particularly the difference in richness of sampling for a given month for the two years, if some consideration is given the differences in weather existing at each period. January and February 1937 were extremely wet, with almost continual rain of average intensity. These two months of high water probably reduced somewhat the organisms normally carried through the winter. The weather by spring became dry, with resulting low water during April, May and June. There were some cloudbursts with some high water toward the end of July. Part of August was dry with a cloudburst or

TABLE NO. 1, NUMBER AND WEIGHT OF ORGANISMS PER SQUARE FOOT OF STREAM BOTTOM

Davidson River Drainage (Weight shown in grams)

	Davidson River		Daniel Ridge Creek		Fork River Branch		Cove Creek		Lookingglass Creek		Avery Creek	
Sq. ft. examined monthly	18		3		3		6		9		9	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Jan 1937	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----
Jan 1938	55	0.960	44	0.613	101	2.552	63	0.728	50	0.691	44	0.835
Feb 1937												
Feb 1938	60	1.064	84	0.977	72	1.207	63	3.073	46	0.958	30	0.466
Mar 1937	44	0.317	88	0.750	44	0.263	26	0.503	63	0.655	40	0.229
Mar 1938	82	0.913	70	1.153	85	1.777	78	1.344	56	0.526	61	1.490
Apr 1937	63	0.780	16	0.750	58	0.963	57	1.710	81	0.825	25	1.162
Apr 1938	64	1.053	63	1.750	31	1.465	82	1.260	37	0.783	29	2.300
May 1937	46	0.658	35	1.002	52	1.200	66	0.949	49	0.474	39	1.132
May 1938	33	0.971	36	0.730	27	0.940	31	1.185	18	2.691	--	-----
Jun 1937	79	0.911	69	0.977	60	1.160	33	3.506	33	0.867	35	0.491
Jun 1938	37	0.831	26	0.602	13	0.350	34	2.090	20	0.971	19	1.918
Jul 1937	131	1.948	65	2.180	133	2.412	54	1.892	27	0.917	50	1.090
Jul 1938	35	0.640	27	0.953	37	7.540	35	2.312	17	0.752	15	0.421
Aug 1937	44	0.694	71	0.750	110	1.445	48	0.908	--	-----	--	-----
Aug 1938	46	0.658	46	0.910	27	0.463	22	1.128	29	0.773	25	0.445
Sep 1937	41	0.839	65	1.180	29	2.060	49	1.887	12	0.326	6	0.091
Sep 1938	48	0.826	55	1.763	25	1.717	51	1.056	24	1.128	15	0.503
Oct 1937	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----
Oct 1938	40	1.050	30	0.767	33	0.393	28	1.097	25	2.748	27	0.942
Nov 1937	25	0.408	21	1.307	32	0.910	30	0.609	21	0.478	10	0.175
Nov 1938	62	1.689	27	2.288	46	0.970	68	1.267	24	0.763	19	0.562
Dec 1937	52	0.860	39	0.950	29	0.363	29	1.132	26	0.517	35	0.321

two early in the month. September was rather wet. The first part of October was dry, but the last part was wet, with high water extending into November. There was heavy anchor ice on the streams with zero weather on December 6 and January 27. In 1938 there was high water during February. There was more high water during April, May and part of June, also during August and the first part of November. September and October were extremely dry. The first cold spell of the winter came the last of November.

Because of the abnormally high water of January and February 1937, it is probable that the data for that spring show a below average population of bottom organisms. The figures for the spring of 1938 are probably nearer normal. Where only a small group of bottom samples is considered, as for example the samples taken in one of the tributaries of Davidson River, it will be noted that in individual months, in certain cases, the weights of the organisms will seem much higher than normal trends would lead one to expect. This is due to one or more large crawfish or salamanders being present in the sample taken. Since comparatively few square feet are examined per month in a given tributary, it occasionally happens that a large individual bottom organism of the families mentioned will throw the average weight for that tributary abnormally high for any given month. Where averages are taken of both the main stream and its tributaries, such high points are smoothed out. Davidson River and its tributaries together represent over 50 square feet of stream bottom per month, so that the average given may be considered reasonably accurate. The mistake should not be made of considering that the average figure for one square foot multiplied by the total number of square feet of stream surface, gives approximately the total actual food available in the stream. All water area does not represent feeding area. The figures

TABLE NO. 2, COLLECTIONS FROM DAVIDSON RIVER DRAINAGE SHOWN IN COMPARISON WITH THOSE TAKEN FROM OTHER WATERSHEDS IN SAME DIVISION OF FOREST (WEIGHT IN GRAMS)

	Davidson River	North Fork French Broad	South Mills River	North Mills River	Big East Fork Pigeon River	West Fork Pigeon River
Sq. ft. examined monthly	51	30	33	18	6	18.
Jan 1937						
Jan 1938	0.918	0.910	0.561			
Feb 1937						
Feb 1938	1.150					
Mar 1937	0.401					
Mar 1938	1.110	1.812	1.444	0.623	0.845	0.889
Apr 1937	1.013					
Apr 1938	1.300					
May 1937	0.913					
May 1938	1.444					
Jun 1937	1.351	1.575	1.125	0.717		
Jun 1938	1.523	1.787	1.150	1.284		
Jul 1937	1.569		0.921		0.696	0.609
Jul 1938	1.235					
Aug 1937	1.048	1.335				0.609
Aug 1938	0.690					
Sep 1937	0.850					
Sep 1938	0.960	1.418	0.681			
Oct 1937						
Oct 1938	1.237			1.752	1.468	0.607
Nov 1937	0.496	1.141	0.661	0.706		
Nov 1938	1.190	1.927	1.071		0.615	
Dec 1937	0.690		0.954			

given indicate the relative richness of the feeding area, and may be considered one of the indices of the state of a stream understood by the word "condition". In making fish plantings in a stream, additional factors need to be considered beside the relative richness of the feeding areas.

FISHING SEASON OF 1938

During the late summer and early fall of 1937, the streams in the Wildlife Management Areas of the Pisgah National Forest were restocked for the first time under the new program. Based on what was determined to be the carrying capacity of these streams, brook, brown and rainbow trout were planted by the most modern methods known to fish culture. Under this program it had been decided that in order to develop and maintain satisfactory fishing in these waters, it was not only necessary to rear and plant good sized fish, but that some system of rotating the open seasons on the several watersheds must be adopted in order that each stream might have a period of rest after being fished and restocked. In view of the fact that all of the streams were planted in the first year's restocking program, it became necessary in order that some fishing be provided, to open a few of these waters in 1938 to a limited number of anglers during short periods throughout the summer.

The results of these openings clearly demonstrated that even when trout of above 6 inches in length are planted in the fall, such fish do not grow sufficiently during the winter months to provide good fishing the following season. This is illustrated

by the 4 days open season on three streams in the Sherwood Management Area. In this area, the stocking was restricted to brook trout only. Under North Carolina laws, brook trout may be legally kept at 6 inches. All fish planted during the fall of 1937 in these streams that were opened were 6 inches or larger. However the very complete record of 445 anglers who brought back 3,059 trout with an average length of 7.25 inches, reported having released approximately 4,000 fish in the hope of catching something larger. Aside from a very few fish that were the result of natural reproduction, everything in the way of trout in these streams should have been of legal length. In the records for streams where rainbow trout predominated, the proportion of released fish to those creeled, was much higher — about six fish returned to the water to one placed in the basket. This was largely due to the minimum legal length of the rainbow being 8 inches instead of 6 as in the brook trout. In conversation with many returning anglers, it was found almost without exception, that those with three or four fish from 10 to 12 inches in length, were far better satisfied than those with the limit of 10 fish just above the legal size.

TABLE NO. 3, SUMMARY OF SEASON'S FISHING - PISGAH NATIONAL GAME PRESERVE

Watershed	Anglers Checked	Total Catch	Brook Trout	Rainbow	Total Weight	Average Length	Average Catch
Davidson River	519	1,929	194	1,735	444 lbs.	8.60 in	3.71
North Fork French Broad	99	397	48	349	92 lbs. 7 ozs.	9.10 in	4.01
North Mills	49	142	0	142	52 lbs.	8.48 in	2.89
	667	2,468	242	2,226	588 lbs. 7 ozs.	8.72 in	3.70

Approximately 6,000 rainbow trout were hooked and released as being slightly under the legal length limit of 8 inches. Close observation on the streams after the close of each fishing period disclosed no dead fish. There were 18 days of open season on the above streams, and on 10 of these days the streams were high and badly discolored. Road construction along 4 miles of the lower Davidson River, and along almost the entire length of Lookingglass Creek, as well as on Avery Creek, kept these streams almost continually disturbed and prevented many anglers from reaching their favorite waters. Perhaps as many as 50 anglers did not fish longer than a half hour each, and many others intending to fish late afternoons and evenings were driven out by heavy rains without fishing at all.

RECOVERY OF MARKED FISH BY ANGLERS

The marking of planted fish for the purpose of growth and migration studies was undertaken for the first time the fall of 1937. The Davidson River and certain of its tributaries were selected for the initial experiment. The method used in marking was the removal of a particular fin or combination of fins for each stream. This removal was accomplished by cleanly severing the fin with a side cutting nail clipper. All fish so marked were held in the pools at the rearing station until the stumps of the severed fins had healed perfectly. No loss of fish followed the operation. 10,-500 brook and rainbow trout from 5 to 7 inches in length were marked and released, and

during the fishing season of 1938, all fish taken by anglers from this watershed were carefully examined and those found marked were weighed and measured individually. Of these 10,500 marked fish, only 376 were recovered by anglers as shown by the records. This is not surprising when the number of hooked and released undersized fish ran to many thousands. The largest of these fish recovered was a rainbow measuring 9½ inches in length and weighing 4½ ounces. The average of the marked rainbows recovered was 8¼ inches, while that of the brook trout slightly under 7½ inches. The records of the fishing for 1939 should begin to show more conclusively the average growth and the extent to which migration occurs. All trout planted during 1938 were marked, so that in the future it will be definitely known whether those captured are the results of artificial propagation or natural increase.

FISH CULTURAL OPERATIONS

Location of Rearing Station: The Trout Rearing Station established during 1937 and operated in cooperation with the Bureau of Fisheries, is located on the headwaters of the Division River in the Pisgah National Game Preserve. It is so situated as to be easily accessible to all the waters under management in this division of the forest.

Water Supply: The water supply for this establishment is taken from the Davidson River about 300 yards above the station. At this point on the stream, a concrete dam diverts the water into an intake box from which it is conveyed through a 12-inch iron pipe line to an open raceway on the station grounds. Under normal conditions the volume of water supplied to the rearing pools is approximately 1,200 gallons per minute. There was a surplus of water for station requirements during the greater part of the past season, although during September and October the stream became so low that no water was passing over the spillway at the dam. During midsummer months, the water temperatures ranged from a minimum of 58° in the early mornings, to a maximum of 69° during the late afternoons. On two occasions during the winter, the water temperatures fell to a low of 32° causing anchor ice to form in the intake box, pipe line and pools. The PH of the water as it entered the distribution raceway, ranged from 6.6 to 6.9, the normal reading being 6.8. The lowest pH was found during the fall when the stream was filled with falling leaves. It also became more acid after heavy rains and when at the lowest stages. A considerable amount of extra work was caused by debris and partially decayed leaves that passed through the trash rack into the intake box when the stream was at flood stages following heavy rains. At these times the coarser floating debris also clogged the rack to such an extent that unless constantly watched and removed, the water supply was completely shut off. The finer material passing through the rack and into the pipeline and pools required equal attention to prevent the screens in the pools from clogging up and running over.

Rearing Pools: The water from the distributing raceway supplies 18 rectangular and circular concrete pools. Those of rectangular shapes are of two sizes, arranged in pairs with walks and grass plots between, and two in a series at different levels. The smaller of these are 6 feet wide, 2 feet deep and 30 feet long, while the larger have dimensions of 8 feet in width, 2½ in depth, and a length of 40 feet. The two circular pools are 25 feet in diameter, and are of the center outlet type. The water levels in these are regulated by flash boards in a control box between the two pools.

From general observations, but without sufficient supporting data upon which to base definite conclusions, the trout appeared to grow much more rapidly in the rectangular pools than in the circular ones. Unquestionably there was less mortality. In transporting the fish for distribution, there was a noticeable difference in the manner in which the fish acted when taken from the two types of pools.

Station Buildings: These buildings consist of a four room and bath standard Forest Service type warden's cottage, used as a dwelling for the station superintendent. It is furnished with heating and cooking stoves, and equipped with electric lights, telephone and hot and cold running water. The exterior is finished with green stained shingles, and the windows and doors trimmed in white. A building finished in the same manner is used for work shop, office, refrigeration and fish food storage and research laboratory. This building is also provided with electric lights and running water. A two car garage of the same exterior finish and trim provides storage for the station truck and superintendent's car. The 2,500 watt Delco lighting plant is housed in a concrete building between the residence and the work shop.

TABLE NO. 4, FISH RECEIVED SPRING OF 1938

Date received	Species	Number	Total Weight	Received from
Mar. 21	Brown Trout	18,000	15.9 lbs.	Leetown, W. Va.
Apr. 5	Brook Trout	20,400	14.4 lbs.	Wytheville, Va.
Apr. 5	Rainbow Trout	25,200	44.9 lbs.	Wytheville, Va.
		63,600	75.2 lbs.	

The foregoing table shows that upon receipt of the fish, it required about 1,125 brown trout; 1,417 brook trout, and 561 rainbow trout to weigh one pound. The brook and rainbow trout were decidedly inferior fish, as were those received the previous year from Wytheville, Va. The mortality records show a much greater loss among these, although they were repeatedly examined for parasites and other diseases without any definite trouble being diagnosed. The fish were too small when received to be satisfactorily handled in the large outside rearing pools, in fact were merely advanced fry.

TABLE 5, KINDS, AMOUNTS AND COSTS OF FISH FOODS USED

Fish Foods Used	Amounts Used lbs.	Cost per cwt.	Total Cost
Beef Hearts	250	$ 9.75-10	$ 24.66
Sheep Liver	9,895	$ 9.75-11.25	1,026.56
Salmon Egg Meal	500	$11.76	58.80
Whitefish Meal	350	$ 3.80	13.30
Seal Meal	800	$ 0.88	7.04*
Total	11,795		$ 1,130.36

* The seal meal was furnished by the Bureau of Fisheries at the cost of freight charges only.

TABLE 6, NUMBERS AND WEIGHTS OF FISH DISTRIBUTED

Species	Numbers	Total weight	Number per pound
Brown Trout	7,500	512 lbs.	14.7
Brook Trout	6,500	695 lbs.	9.3
Rainbow Trout	18,620	1,639 lbs.	11.3
Total	31,620	2,846 lbs.	

In addition to the fish shown as distributed in Table 3, experimental plantings of 1,400 brown trout and 4,300 brook trout were released without their weight being recorded.

There were on hand at the rearing station at the end of 1938, approximately 900 brook trout of about six inches in length, and 6,000 brown trout slightly larger. It is intended to carry these fish over into the yearling stages, and plant them in South Mills River after the fishing season is over next summer.

Methods of Planting: 1. The dates for planting were governed by the condition of the streams; the time at which the particular species had attained the required size, and the availability of trucks and personnel for handling the transportation and distribution.

2. The fish were transported from the Trout Rearing Station in Forest Service and Bureau of Fisheries trucks.

3. The fish were marked, counted, weighed and properly loaded on the trucks by the personnel at the rearing station.

4. At the most accessible points on the streams to which the fish could be transported and quickly carried to the water, specially designed live boxes were placed in position in the stream previous to the arrival of the trucks. The planting crew composed of a suitable number of CCC enrollees, supervised by either one of the Fish Management personnel or a Federal or State Game Warden, were in readiness to handle the fish as soon as the truck arrived. The fish were quickly unloaded from the truck, carried to the stream where the live box was located, and, after tempering, placed in this box to rest before being distributed. From this box the fish were transferred to the special pack can and scattered a few in a place over the entire section of the stream to be covered from this particular planting point. The crew then removed the easily portable live box from the stream and carried it to the next location in readiness for the following truck load.

FISH PARASITES ENCOUNTERED AND MEASURES USED IN CONTROL

The parasite most frequently causing trouble at this station is an intestinal protozoan Octomitus. As it made its appearance almost immediately following the receipt of the fish in the spring, it undoubtedly was present in an intracellular stage when the fish were delivered. The brown trout seemed to be the most susceptible, although both brook and rainbow trout were found to be infected with the parasite on

one occasion. The treatment to which the fish responded most readily was the incorporation in their food of one gram of calomel to 10 pounds of meat. This is thoroughly mixed in a granite container and allowed to remain over night in the refrigerator. One feeding usually suffices to eradicate the parasites.

The only other parasite with which the trout have been infected at this station is the trematode, Gyrodactylus. These are external parasites usually attacking the fins and bodies of the fish. The treatment most effective is dipping the fish in a solution of one part of acetic acid to 500 parts of water, allowing the fish to remain in the solution one minute.

SOME EXPERIMENTS ON THE USE OF SALMON VISCERA, SEAL MEAL, BEEF PANCREAS, AND APPLE FLOUR IN THE DIET OF YOUNG CHINOOK SALMON (Oncorhynchus tschawytscha)

By L. R. Donaldson, School of Fisheries, University of Washington
and Richard F. Foster, Oregon State Fish Commission

SALMON VISCERA have been used as a food for young salmon and trout along the Pacific Coast for many years, but we are unable to find reports of comparative and evaluation tests. It was desirable to measure the efficiency of the salmon viscera in producing growth of young salmon and trout, and that its general nutritional significance be understood. Comparisons were made with beef liver and salmon viscera as straight diets or combined with other products, such as seal meal, beef pancreas, and apple flour.

Feeding Tests: The feeding tests were carried on at the experimental hatchery of the University of Washington in cooperation with the Fish Commission of Oregon and the U. S. Bureau of Fisheries. Young chinook salmon (Oncorhynchus tschawytscha) served as test animals, with an initial 2000 fish in each lot. At the end of 12 weeks time the number of fish in each lot was reduced to 1000 to prevent over-crowding. Eight lots of fish were used in this series and a summary of the results is given in Tables 1 and 2 and Figures 1 and 2. (In the figures the points through which the curves were drawn represent the average weight, in grams, of samples weighed at two-week intervals.) The experimental feeding started as soon as the fish had completely absorbed the yolk sac and was continued for 20 weeks. The water temperature during the experiment ranged from 43° to 62° F.

The control, lot No. 1, received beef liver exclusively. Care was exercised to obtain fresh liver as it was deemed undesirable to use frozen storage liver in this series of feeding tests.

The fish in lot No. 2 received ground salmon viscera exclusively. The viscera used contained the eggs (immature), testes, stomachs, intestines, livers, etc. The

material, as obtained from the fish packing plants, was placed in cartons and maintained in a frozen state until ground and used. The storage period was approximately one and one-half years.

The fish in lot No. 3 were fed a diet composed of 40 percent fresh beef liver and 60 percent by weight of seal meal. The seal meal used was prepared by the U. S. Bureau of Fisheries at their plant on the Pribilof Islands. Before feeding, all the seal meal used was sized by passing it through a No. 32 wire sieve.

The fish in lot No. 4 were fed a diet made up of a mixture of 40 percent ground salmon viscera and 60 percent seal meal.

The fish in lot No. 5 were fed a mixture containing 20 percent beef liver, 20 percent salmon viscera, and 60 percent seal meal.

The fish in lot No. 6 received a mixture of 1/3 beef liver, 1/3 salmon viscera, and 1/3 seal meal.

The fish in lot No. 7 were fed a diet composed of 20 percent beef liver, 20 percent fresh finely ground beef pancreas, and 60 percent seal meal.

The fish in lot No. 8 received a mixture composed of 40 percent by weight of beef liver, 40 percent of seal meal and 20 percent of apple flour. The apple flour used in this diet was obtained from an apple by-products company. In processing, the entire cull apples were sliced and dried. The dried apple flakes were then ground to a fine texture usable for feeding small fish.

The variation in water content and availability of the various food combinations were adjusted by controlling the amount of food fed. The fish in lots Nos. 1 and 2 were given as much food as they would consume without waste. Using the liver lot (No. 1) as a basis, lots Nos. 3, 4, 5, 7 and 8 were fed during the first 12 weeks of the experimental period 35 percent as much total food by weight as was fed to the liver lot, and the fish in lot No. 6 were fed 60 percent as much by weight of the mixed diet as was fed to the No. 1 lot. During the last 8 weeks of the experimental period the percentage fed to lots Nos. 3, 4, 5, 7 and 8 was increased to 50 percent and that of lot No. 6 to 80 percent of the total weight of food fed to the fish in lot No. 6 to 80 percent of the total weight of food fed to the fish in lot No. 1. These increases were made in an effort to increase the growth rate more nearly to that of the control lot No. 1.

In feeding the fish in lots Nos. 3, 4, 5, 7 and 8 a wire sieve was used to size and scatter the food particles. The foods in this group were of such consistency that they could easily and efficiently be mixed in the "blower type" of mixer.

Results: - The fish in lot No. 1, the control group, produced the greatest total weight increase, but it was produced at the greatest cost per pound of any of the experimental lots. In the 20 weeks the average increase in weight was 727 percent; a total of 11,900 grams of liver was consumed. A pound of fish was produced from

each 2.70 pounds of food fed. The purchase price of the liver used was $0.05 a pound, or the cost for food was $.135 for each pound of fish produced.

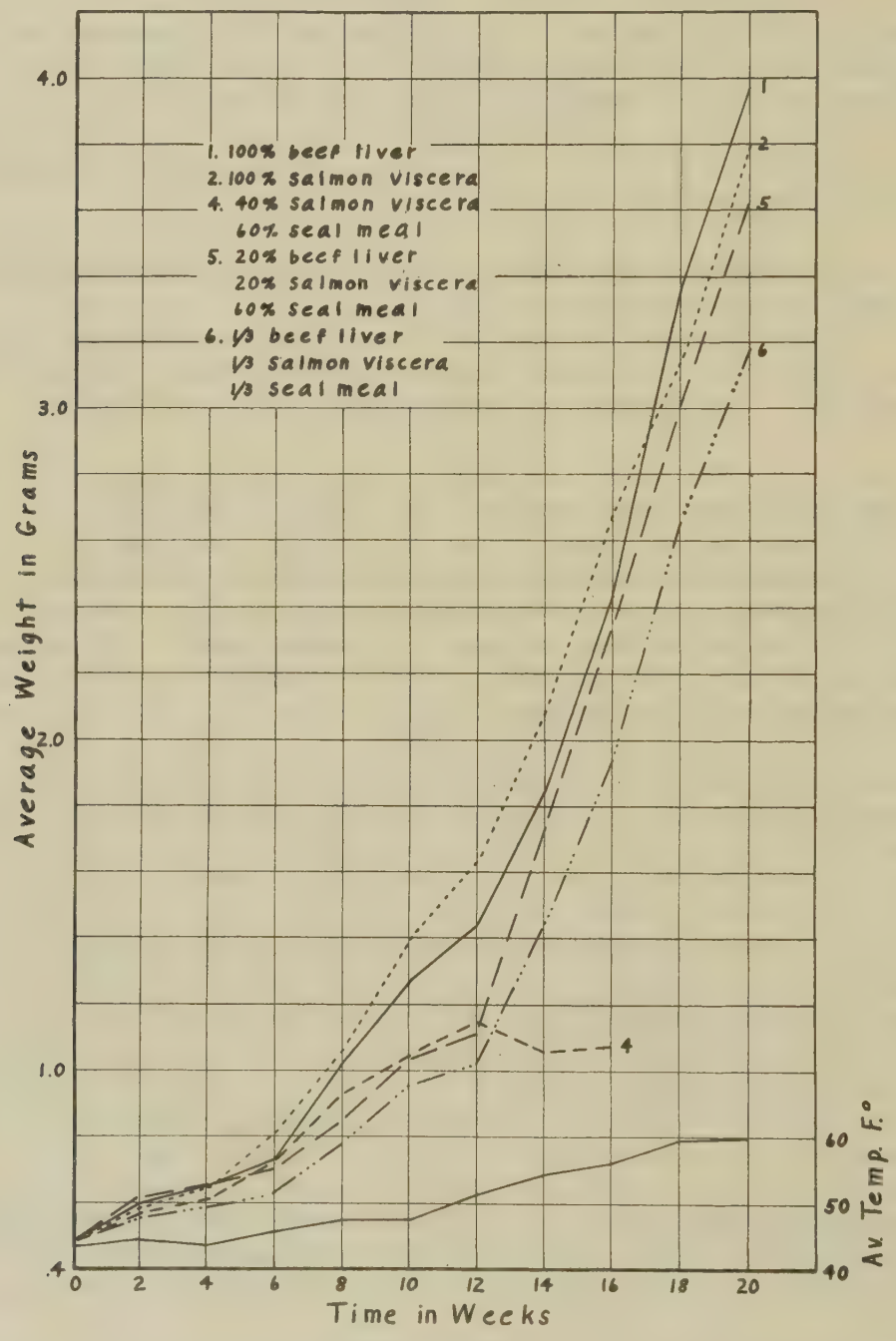

FIGURE 1

The fish in lot No. 2, fed salmon viscera, increased 692 percent in weight. They consumed 15,475 grams of food; 3.57 pounds of food were required for each pound of fish produced, or at $0.02 a pound for the frozen salmon viscera the cost of producing a pound of fish was $0.071.

The fish in lot No. 3, fed the mixed diet of beef liver and seal meal were fed less food than they would actually have consumed if given sufficient to satisfy them. As a result the growth was controlled so as not to exceed that of the liver lot, No. 1. These fish increased 650 percent in weight and were fed, as were lots Nos. 5, 7 and 8, a total of 5,185 grams of the mixed diets. At a cost of $0.05 a pound for the liver used and $0.01 a pound for the seal meal, the fish in this lot were produced for a food cost of $0.036 for each pound of fish produced.

The fish in lot No. 4, fed the same percentage diet composition as those in lot No. 3, except for the substitution of salmon viscera for beef liver, grew at a rate similar to the other lots during the first 12 weeks of the experimental period (Figure 1). After this initial period the growth rate dropped off and the mortality became so excessive that this lot was discontinued at the end of the 16 week.

The addition of 20 percent liver to the diet, and a reduction of the salmon viscera to 20 percent, with 60 percent seal meal, as fed to the fish in lot No. 5 in comparison with those in lot No. 4, proved to be very beneficial in producing sustained growth. The total increase in average weight for the fish in this lot was 654 percent; 1.49 pounds of food were required for each pound of fish produced, or the food cost was $0.03 for each pound of fish.

The three part mixture, composed of one part each of beef liver, salmon viscera, and seal meal and fed to the fish in lot No. 6, was of a consistency difficult to feed and was not efficiently utilized. The fish in this lot were fed a total of 8,500 grams of the mixed diet while increasing 560 percent in weight. It required 2.7 pounds of food for each pound of fish or a cost of $0.072 for food for each pound of fish produced.

The fish in lot No. 7 that received the 20 percent beef pancreas supplement to their diet were fed the same total amount of food as were the fish in lots 3 and 5, but did not utilize it as efficiently, for they increased only 592 percent in weight. A total of 1.56 pounds of the mixed food was required for each pound of fish produced, or, at a cost of $0.05 a pound for the beef pancreas, $0.05 for the liver, and $0.01 for the seal meal, the cost for food was $0.041 for each pound of fish produced. A microscopic examination of a sample of the fish in lot No. 7 at the termination of the experimental period failed to reveal any traces of fatty degeneration although the fish in lots No. 3 and 5 showed all the characteristic symptoms of this disorder. Although the beef pancreas was not as efficiently utilized as either the beef liver or the salmon viscera, it may have dietary essentials that tend to aid in regulating the metabolism of the fish. Microscopic and chemical studies are under way to test this possibility.

The fish in lot No. 8, fed the 20 percent ground apple flour in addition to the 40 percent seal meal and 40 percent beef liver, increased at the slowest rate of any of the eight lots. The total average weight increase was 448 percent, with 1.98 pounds of food required for each pound of fish produced, or, at a cost of $0.03 a pound for the apple flour, the cost for producing each pound of fish was $0.059. The apple flour was used in the diet to add bulk to the food when consumed, and in this regard it served very well. The fish were fed on the reduced schedule based on the

amount of liver consumed by lot No. 1. The reduced amount however was very close to the maximum amount that the fish in this lot would eat, and a great deal of effort was often expended to get them to consume all the food mixture allotted to them.

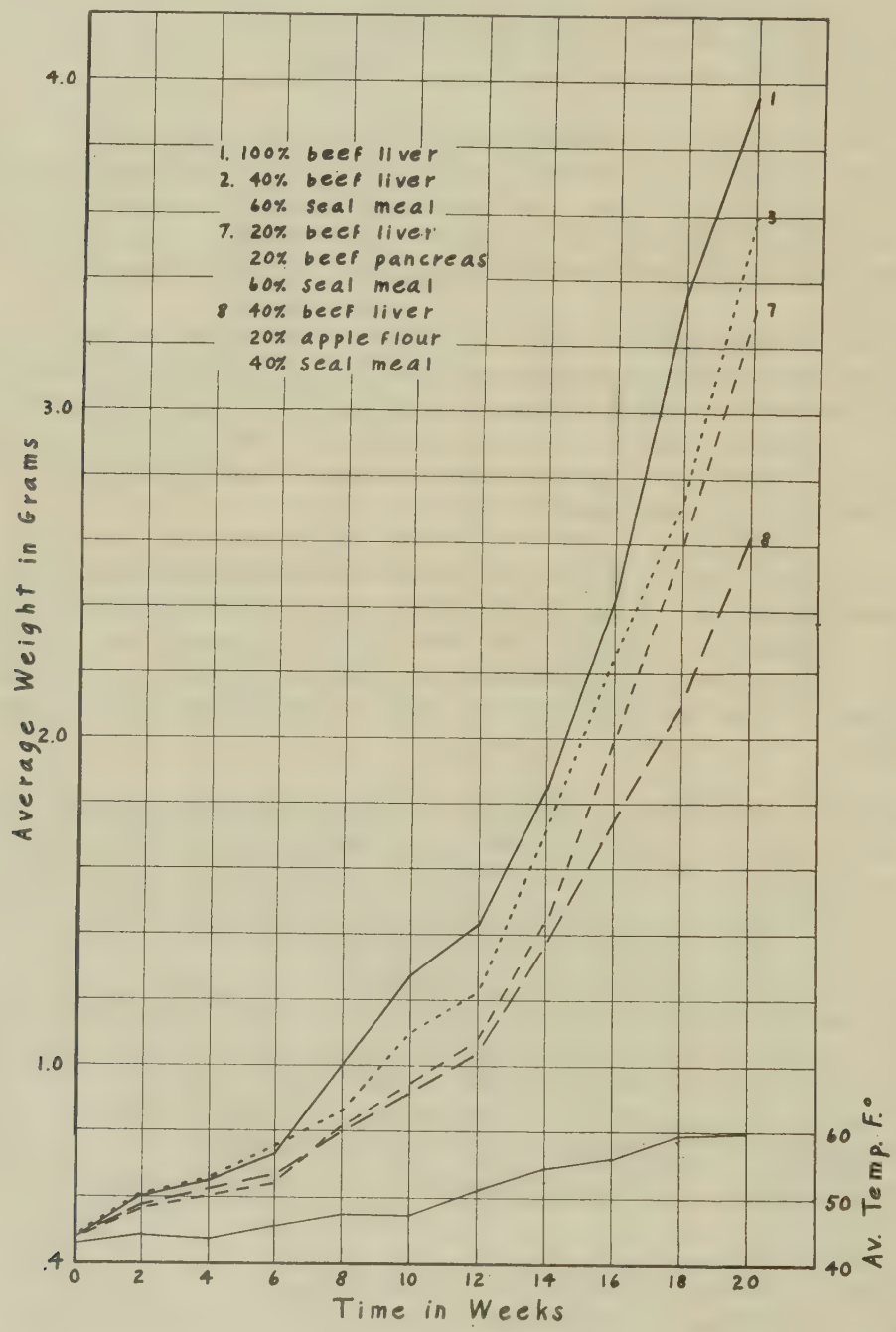

FIGURE 2

The mortalities experienced by the various lots are presented in periodic cumulative form in Table 2. The uniform trend evidenced in lots Nos. 1, 2, and possibly 6, would seemingly indicate acceptable diets. The sharp rise in the mortality rates of lots Nos. 3, 5, 7, and 8 during the last two weeks of the experimental period seem to indicate that under the conditions of this experiment the fish were nearing a breaking point.

Summary and Conclusions: Beef liver, salmon viscera, seal meal, beef pancreas, and apple flour were fed experimentally to young chinook salmon fingerlings. The feeding tests were of 20 weeks duration.

By reducing the amount of food fed to those lots of fish that received a percentage of seal meal in the diet the rates of growth were maintained slightly below that of the liver control lot.

Salmon viscera proved to be a very satisfactory food when fed as a straight diet to young chinook salmon. Salmon viscera combined with seal meal proved to be unsatisfactory as a continuous diet. The addition of 20 percent beef liver to the combination of salmon viscera and seal meal materially improved the rate of growth and survival of the fish.

The so-called "dry-mixtures" were much easier to feed, produced better growth, and at a reduced cost per pound than the so-called "wet-mixtures".

Beef pancreas added to the diet was not as efficiently utilized in producing growth as either the salmon viscera or the beef liver in similar combinations, but the pancreas may contain dietary essentials beneficial in proper metabolism.

Apple flour used in the diet to provide bulk proved to be very satisfactory in this regard but did not contribute to any extent to the growth of the fish.

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SUMMARY OF EXPERIMENTAL FEEDING TESTS WITH
CHINOOK SALMON FINGERLINGS AT THE
UNIVERSITY OF WASHINGTON EXPERIMENTAL HATCHERY

Experiment started: January 26, 1938. Concluded: June 15, 1938.

Initial number of fish per trough: 2000 (1000 after April 20)

Average water temperature: 51°F.

	Lot Number						
	1	2	3	5	6	7	8
Initial average length - cms.	3.26	3.26	3.26	3.26	3.26	3.26	3.26
Average length at report - cms	6.76	6.59	6.55	6.46	6.37	6.15	5.77
Percent gain	107	102	101	98	95	89	77
Initial average weight - grams	.48	.48	.48	.48	.48	.48	.48
Average weight at report-grams	3.97	3.80	3.60	3.62	3.17	3.32	2.63
Percent gain in weight	727	692	650	654	560	592	448
Condition factor	1.29	1.33	1.28	1.34	1.23	1.43	1.37
Mortality number	75*	83*	64*	70*	76*	86*	52*
	6	6	21	97	19	41	23
Percent mortality	3.75*	4.15*	3.2*	3.5*	3.8*	4.3*	2.6*
	.6	.6	2.1	9.7	1.9	4.1	2.3
Total wt. of food fed - grams	11,900	15,475	5,185	5,185	8,500	5,185	5,185
Efficiency factor	.37	.28	.73	.67	.37	.64	.51
Lbs.of food to produce 1 lb. fish	2.70	3.57	1.37	1.49	2.70	1.56	1.96
Cost per lb. of fish	$ .135	0.071	0.036	0.03	0.072	0.041	0.059

Diets: Lot No. 1. 100% beef liver
" " 2. 100% salmon viscera
" " 3. 40% beef liver
60% seal meal
" " 5. 20% beef liver
20% salmon viscera
60% seal meal
" " 6. 1/3 beef liver
1/3 salmon viscera
1/3 seal meal
" " 7. 20% beef liver
20% beef pancreas
60% seal meal
" " 8. 40% beef liver
40% seal meal
20% apple flour

Cost of foods used: Beef liver 5¢ per lb. Salmon viscera 2¢ per lb.
Beef pancreas 5¢ per lb. Seal meal 1¢ per lb.
Apple flour 3¢ per lb.

* Upper figures pertain to first 12 weeks, lower figures to last 8 weeks.

Table II.

CUMULATIVE MORTALITY NUMBERS

First period (12 weeks)	Lot Numbers 1	2	3	4	5	6	7	8
Feb. 9	16	34	25	12	17	18	21	21
Feb. 23	37	51	36	27	38	34	53	29
Mar. 9	51	60	55	44	51	51	66	35
Mar. 23	61	69	58	51	61	61	79	45
Apr. 6	72	76	60	56	64	74	84	51
Apr. 20	75	83	64	79	70	76	86	52
*Second period (8 weeks)								
May 4	1	3	1	44	0	2	0	1
May 18	3	4	2	206	4	5	0	2
June 1	4	6	4	Dis-	9	12	1	6
June 15	6	6	21	con-	97	19	41	23
				tinued				
				May 18				
TOTAL	81	89	85		167	95	127	75

Diet: Lot No. 1. 100% beef liver
" " 2. 100% salmon viscera
" " 3. 40% beef liver
60% seal meal
" " 4. 40% salmon viscera
60% seal meal
" " 5. 20% beef liver
20% salmon viscera
60% seal meal
" " 6. 1/3 beef liver
1/3 salmon viscera
1/3 seal meal
" " 7. 20% beef liver
20% beef pancreas
60% seal meal
" " 8. 40% beef liver
20% apple flour
40% seal meal

* All lots reduced to 1000 fish on April 20.

STARCH DIGESTION IN TROUT

By Frank H. Connell and Eddy Davis Palmer
Dartmouth College, Hanover, N. H.

THE QUESTION of the ability of trout to digest and assimilate starch is important to those who try to prepare sensible trout diets. Wheat products are widely used because they are cheap and because they serve as a satisfactory binder. But if they pass through the fish undigested, their use as food proves expensive. They may, in fact, actually be harmful in the hatchery. At one of the New Hampshire hatcheries a commercial starch product was added to the diet during October 1937. With a 30 percent mixture of this meal in the diet starch-laden fecal material settled to the bottom of the ponds in large quantities. Though the fish remained healthy a luxuriant growth of fungus covered the bottom of the ponds and along with excreta was carried into the drainage pipes, where it caused great inconvenience by plugging the lines. The condition existed throughout the winter and spring of 1937-38 and was at its worst in March when the water temperatures in some of the lower ponds were as low as 34° - 36°F. No relief was obtained until the percentage of meal in the diet was cut to about 10 percent.

An investigation to test the ability of trout to digest starch was reported by McCay and Tunison (1937), who concluded that 93-99 percent of raw and cooked starch was utilized by trout held between 46° and 48° F. Their method involved precise analysis of feces which had remained free in the water from 12-48 hours.

From the work of McCay and Tunison and our observations in the hatchery it seemed that there must be a rapid and wholly logical loss in efficiency of starch digestion by trout with falling water temperatures.

To determine the temperature at which it became no longer profitable to feed the starch containing commercial meal a series of experiments was set up. As we were not interested in whether trout could utilize starch at all but at what point it was no longer profitable to include starch in the diet no attempt was made to carry out exact and time consuming quantitative analyses. Brown, brook, and rainbow trout, both yearlings and fingerlings, were used. A food mixture consisting of 75 percent ground fresh pig liver plus 25 percent meal by weight was fed, except in one experiment where rice starch was substituted for the meal.

To test for starch the fish were anesthetized in urethane, and with great care a very small amount of material was gently expressed from the rectum. Every precaution was taken to eliminate the possibility of collecting material which had not already reached the anus. D'Antoni's iodine solution was added to the specimen which was then examined under the microscope.

With diets containing raw meal (Rowena Ration No. 5) at 1 and 2 degrees C. (34°-35° F) 6 hours since the last feeding, the feces were heavily starch laden. After 2½ hours and 28 hours at temperatures of 15½ and 16 degrees C (60°-61° F) the same results were obtained. This was also true for diets containing meal boiled 45 minutes and powdered rice starch at 16 degrees C after 20 hours.

Rice starch with its smaller grains presented no more evidence of digestion than the wheat starch. Each specimen stained so heavily with idoine that the strong blue color was obvious to the eye. Microscopically some little etching of the wheat starch grains could occasionally be noted.

Our findings are so completely at variance with those of McCay and Tunison that we are at a loss to explain the almost diametrically opposed results. We feel that our specimens were fair samples of the type of fecal material being passed by the fish. The deposits of starch in the excreta on the bottom of the ponds seem to confirm this opinion, especially since the fish were healthy and cleaned up their food avidly. Furthermore, fish killed after examination showed the intestine to be starch-laden. Our experiments would seem to allow no other conclusion than that trout are unable to utilize either wheat or rice starch in appreciable quantities.

REFERENCE - McCay, C. M. and Tunison, A. V. 1937 Cortland Hatchery report no. 5 for the year 1936, pp. 10-13.

FURTHER NOTES ON HEATING WATER FOR THE CULTURE OF TROUT

By T. S. Kibbe, Superintendent
U. S. Fisheries Station, Spearfish, S. D.

IN THE MAY, 1938 issue of the PROGRESSIVE FISH CULTURIST, No. 38, page 19, there appeared an article entitled "An Experiment on Heating Water for Fish Culture Purposes". Since this article appeared, further studies were made and heating the water supply now is a routine activity, at this, the Bureau's Spearfish, South Dakota station. Herewith are the subsequent data and comment regarding this experiment. A set of 5 gas fired, copper coiled water heaters similar to those described in above mentioned article was installed as a permanent part of the station's equipment. Each heater cares for three standard hatching troughs arranged in the conventional terraced manner and the heaters are vented in such a way that little additional heat is needed to keep the hatching room comfortable, even in severe weather. The expense in heating this water may be lowered by rearranging the trough system and using the water more times.

Fish culturists at cold water stations know the hazards and dissappointments encountered in incubating eggs in water having temperatures below 40 degrees F. The eggs usually hatch before the proper number of temperature units are absorbed and the resultant fry and fingerlings are weak, many being prematures, and raised with considerable losses and difficulty. This condition is comparable to any premature birth.

The accompanying tables show the data of the experiment, installation, equipment, maintenance costs, etc.

At this station natural gas was used, it being available at reasonable cost. However, at stations where gas cannot be procured, coal may be used economically and entirely satisfactorily. There are many types of coal hot water heaters that may be used. One such heater is the standard 450 gallon heater described in Montgomery Ward & Company's catalogue and sells for $44.25. More than one such heater could be used if necessary. The installation is simple. It is merely necessary to connect the heater to the water supply and allow the heated water to spill into the head or distribution trough and mix with the cold water. By simply adjusting the flow into the head trough, the desired temperature can be secured. In this type of temperature control there would be some temperature fluctuation but this change would be slow and comparable to the normal changes in the open streams and would in no way harm the fish or eggs. Time necessary to operate the heaters will not seriously interfere with the station's normal routine since the night attendant can do many duties such as egg picking, etc.

Summarizing the results of the experiment: The eggs hatched from the heated water produced fry and fingerlings infinitely superior to those of the cold water. The tender stage was reduced to a minimum interval thus saving many eggs that would be killed from the necessity of handling during this stage. It also permits earlier shipping of the eyed eggs and produces larger and more vigorous fingerlings for distribution. Since most of the cold water conditions are experienced during the winter months, the cost of operating these heaters is small in that they contribute no small measure in heating the hatching room.

LOSSES OF EGGS AND FRY AND OTHER RELEVANT DATA IN EXPERIMENTAL AND

CONTROL LOTS OF LOCH LEVEN EGGS AT SPEARFISH, SOUTH DAKOTA, STATION

	Experimental Lot	Control Lot
Number of eggs in lot	15,580	11,020
Total green egg loses	711	359
Number taken for samples for weekly submission to regional and Washington offices	500	500
Eyed eggs by measurement	14,723	10,128
Percentage eye (eggs taken by different spawntakers)	95	96
Eyed egg loss to February 20	829	61
Fry loss to February 20	351	

Note: Eyed egg loss on control lot incomplete due to termination of experiment before this lot hatched.

COMPARATIVE RATES OF DEVELOPMENT OF LOCH LEVEN TROUT EGGS IN

EXPERIMENTAL AND CONTROL LOTS AT SPEARFISH, S. D., STATION

	EXPERIMENTAL LOT	CONTROL LOT
Eggs taken from station brood stock	November 14, 1938	November 14, 1938
Eggs eyed and washed	December 21, 1938	February 15, 1939
Eggs began hatching	January 11, 1939	
Eggs finished hatching	January 18, 1939	
Fry began taking food	January 28, 1939	
Experiment closed	February 20, 1939	February 20, 1939
Status of the two lots	Fingerlings # 1 average 21.9 mm overall length	Eyed eggs, just ready for shipment.

OPERATING COST[1/] AND EFFICIENCY OF HEATERS USED IN EXPERIMENT AT SPEARFISH, S. D., STATION

MONTH	Mean Temperature Heated Water	Mean Temperature Unheated Water	Mean Rise Deg. F.	Gallons Per Minute	Days	Cost Per Day at 30¢ per M cubic feet	Total Cost
November	45.03 F.	38.79 F.	6.24	5.5	16	$0.1498	$2.40
December	46.21	36.63	9.58	5.5	31	0.2299	7.13
January	46.82	36.14	10.68	5.5	31	0.2563	7.95
February	47.10	34.45	12.65	5.5	20	0.3036	6.07
Entire Period	46.39	36.38	10.01	5.5	98	$0.2402	$23.55

[1/] Careful check of meter readings under various conditions established the norm for gas consumption of one heater, at a raise of ten degrees F and 5.5 gallons per minute flow, to be 800 cubic feet per 24 hours. The calculations of cost shown above are based on this figure.

EQUIPMENT USED FOR HEATING THE STATIONS WATER

SUPPLY AT SPEARFISH, S. D. STATION

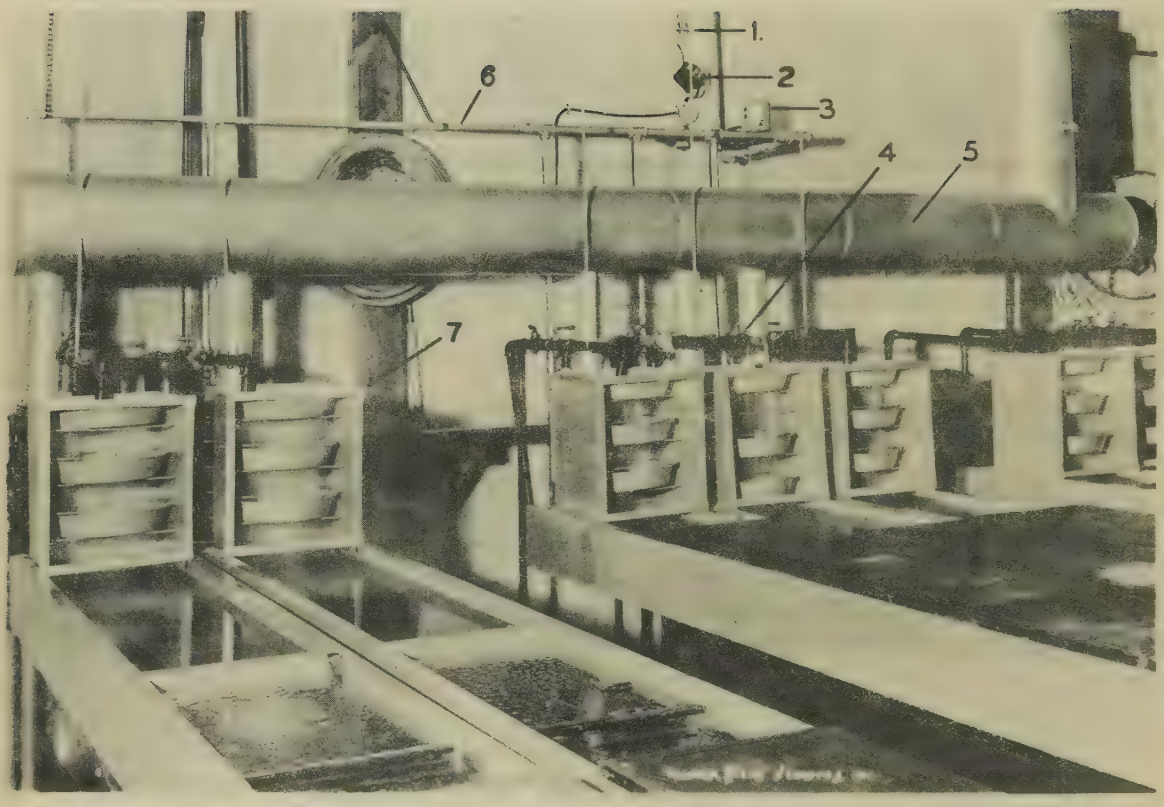
Five Hotstream No. 80 triple coil water heaters
One Minneapolis Honeywell remote control with bulb and thermostat
One Minneapolis Honeywell motorized gas valve No. V150
One transformer necessary to operate alarm and thermostat from light circuit
Alarm bells and batteries
Pipe and fittings necessary for complete installation
Wiring to connect with alarms
Sheet metal for single and manifold vents for use to heat hatchery room

Complete cost of above equipment including installation - - $260.00

This equipment is installed in such a way that the motorized valve controls the gas supply to all heaters. The valve is operated by the thermostat and closed at any predetermined temperature. Any interference with the gas or water supply closes this valve and sets the alarms ringing. Should the gas go off, the temperature change is slow enough so no damage will be done. Pilot lights in each heater operate independently of the controls and may be turned off when the heaters are not in use. Heaters have a screw adjustment and also a hand valve. Rate of operation may be set with the screw adjustment and the heater then may be turned off with the hand valve at any time without the necessity of readjusting the flame when it is turned on.

Vent pipes from the heaters are connected into a single 14-inch manifold pipe that serves to utilize waste heat for heating purposes in the hatchery room. A surprising amount of heat is given off by the vents and this heat is sufficient to keep the room warm in ordinary winter weather.

An alarm system is arranged so that it will ring instantly when motorized valve closes. Any interference with the gas or water supply will close this valve. At the Spearfish Station the alarm system is connected to the Hatchery and to each residence.



HEATING INSTALLATION, SPEARFISH, SOUTH DAKOTA

1. Fuse plate

2. Transformer

3. Motorized valve. This valve works from the thermostat bulb and contains a mercury alarm bulb. When the water reaches any predetermined temperature this valve closes the gas and causes the alarm system to ring. This would happen during a water failure, or any other interference with the system.

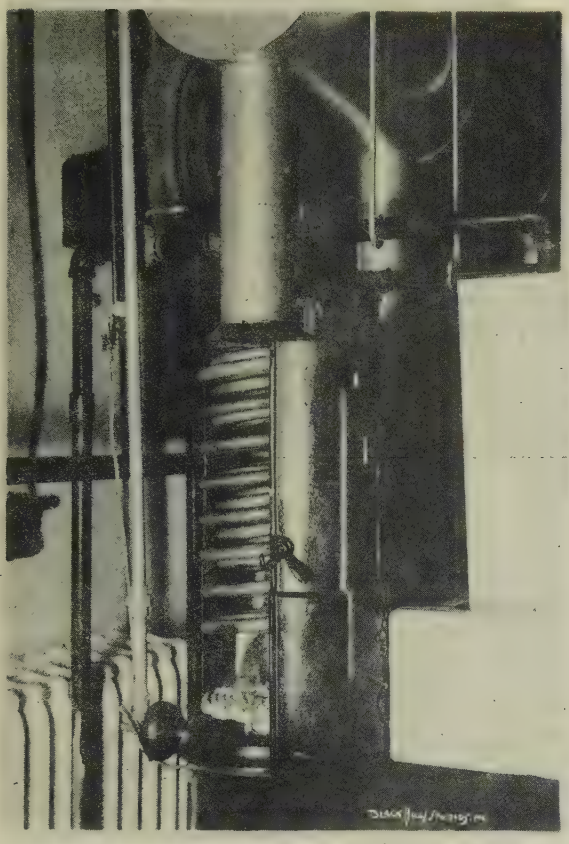
4. Thermostat bulb. Controls the motorized valve.

5. Vent manifold. This large pipe collects the waste heat and aids greatly in heating the hatchery room.

6. Gas service line.

7. Water aerators.

CLOSE-UP OF THE HEATER SHOWS THE BURNER IN DETAIL



The small vent pipe from this heater conceals the second water valve. By manipulating these water valves, any amount of water may be by-passed to the troughs, thus regulating the water temperature. This also may be done by adjusting the gas supply valve regulating the flame. The small pipe parallel to the gas supply to the heater is the pilot supply. The heater itself is a triple coil, ordinary gas water heater that may be purchased in any plumbing supply house.

PROPAGATION OF CHANNEL CATFISH

By A. G. Morris
Superintendent, Chesapeake State Fish Hatchery, Mt. Vernon, Mo.

ALTHOUGH MISSOURI has classed the channel catfish (Ictalurus punctatus) as a game fish and has protected it by law for years, as has several other states, no successful effort has been made toward the propagation of this fish until the past three years. The channel catfish hatchery at Chesapeake is a part of the bass hatchery of twenty-three lakes, and is a result of a study of the hatchery of the Kansas Game and Fish Department and three years of experiments here. No doubt it can be improved upon, and will be as time goes on, but we have found our method successful to date.

Briefly, the system consists of incubating the masses of eggs in baskets placed in hatching troughs supplied with running water which is gently agitated by a series of paddles powered by water wheels, and later removing the fry to growing troughs.

Channel catfish being of the warm water type must necessarily be raised in warm water. The temperatures of the lake from which our water supply for the hatchery is taken by gravity flow was as follows for this season:

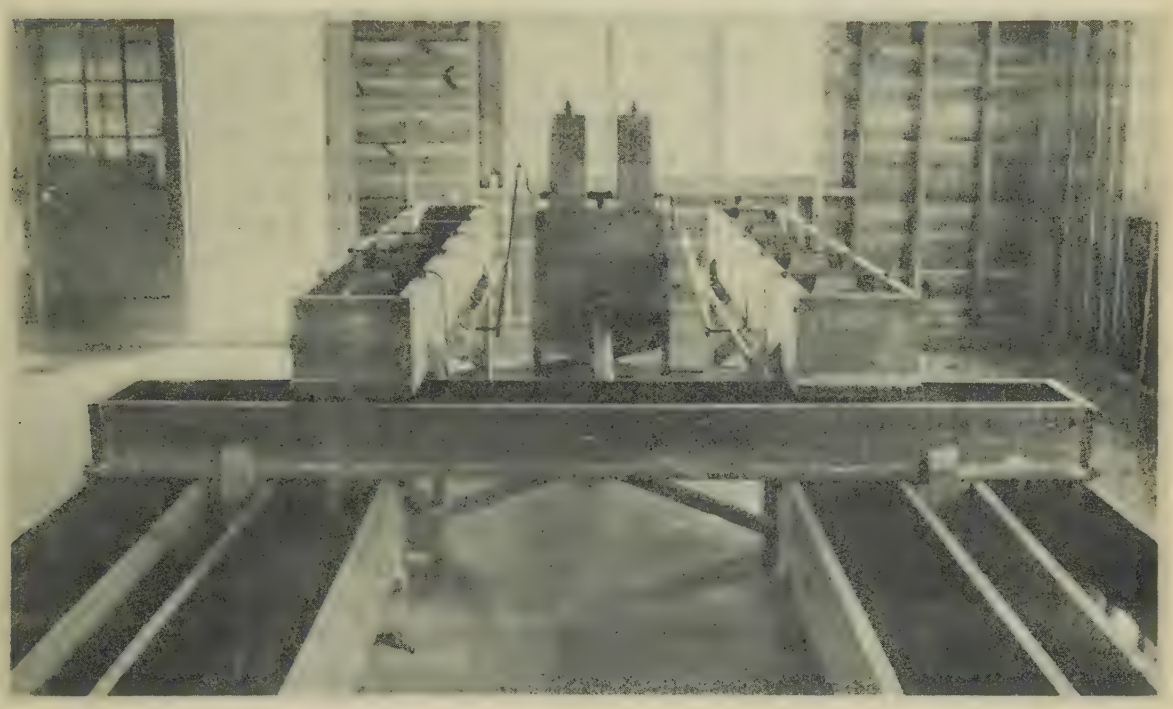
Date	Water	Air	Date	Water	Air
April 13, 1938	62°F.	82°F.	June 13	84°F.	90°F.
23	66°F.	74°F.	23	84°F.	90°F.
May 3	68°F.	70°F.	July 3	88°F.	98°F.
13	71°F.	72°F.	13	88°F.	96°F.
23	80°F.	82°F.	23	90°F.	96°F.
June 3	73°F.	76°F.	Aug. 3	90°F.	98°F.

The lake is spring fed and contains 6.5 acres of water. The hatchery draws its supply from a 6" line that takes its water three feet from the surface of the lake. This intake line to the hatchery is on the opposite side of the lake from the intake to the lake.

The building is 30' by 32', equipped with concrete floor, and suitable drains to take care of waste water. The inside of the hatchery resembles a trout hatchery inasmuch as it has 14 troughs. Four of these troughs are used as hatching troughs located above the other troughs. Two are control troughs, and are located directly below the hatching troughs to control the amount of water going into the 8 growing troughs which are directly under the control troughs. The apparatus is built in two distinct parts in order that water may be conserved when very few fish or eggs are in the hatchery. For the same reason the water that goes through the hatching troughs and over the wheel is all used the second time by dumping it into the control trough and on through to the growing troughs.

Each section has two 36" high by 6" wide overshot water wheels which are powered by a 1½" stream of water that is reduced to 1" just before it hits the wheel. In order that there be less water splashing over the hatchery the wheels are enclosed in a galvanized cover. Each wheel pulls five paddles in a hatching trough which is located at its side. The paddles are made of galvanized iron and reach down into the trough to within 1½" of the bottom. The wheels are so arranged that they may be used together or they may be run alone when only five spawns or less are being hatched. The speed of the wheels has never been taken but they are not fast when in use, only fast enough to push the water down into the spawn of eggs as much as possible and still not beat them to pieces. My guess is that they run around 50 to 60 revolutions per minute. In order to give the water more "push" at the wheels it is fed from the lake to the hatchery through a 6" line. However, a three inch stream of water would take care of the hatchery in good shape, with all four wheels going, which would hatch twenty spawns of eggs at once.

Unlike some of the other fish, it seems, that with channel catfish the larger the brood fish the larger the spawn. From an eight pound fish we secured a spawn of two pounds and this spawn hatched out 6,225 fish. Spawns are taken by placing nail kegs and twenty gallon wooden kegs in the lakes for the fish to spawn in, being sure there are no other places where the fish can find a hole in the bank. The spawns taken this year were all taken on May 28, May 31, June 2, and June 6. In removing the eggs from the keg it is necessary to use care or the spawn will be torn apart.



INTERIOR OF CATFISH HATCHERY

The water wheels in the background operate paddles in the 2 hatching troughs on either side. Water is supplied to the 4 growing troughs in the foreground from the hatching units through the head trough, center.

If you see the fish go out of the keg when you raise it and have reason to believe the eggs are either unfertile or are not all there the fish will come back and finish the job if you will leave the eggs. Eggs must be transferred to the hatching troughs in a container filled with water. The eggs are placed under the paddles in small containers made of 1/4" mesh hardware cloth the shape of a box, but low enough to allow the paddle to work over the center of the spawn. This will enable the small fish to get out of the container when they hatch and will not allow the paddle to wash the spawn over to one side.

The eggs require seven days to hatch. When they hatch the fish will go to a quiet eddy in the trough and they should be left there, with the paddles turned off if possible, until they are three days old. At this age they have absorbed the egg sac and are more able to stand the transfer to the lower rearing troughs. I have tried about everything in getting the fish out of the trough at this age; most of them haven't worked. I now use a brush and sweep them out, keeping a constant stream of water on them while sweeping. At this age they are transferred to the growing troughs and the job of feeding starts.

We have experimented with various kinds of food and due to the supply have settled down to ground goldfish and dried buttermilk. The fish are scaled and the fins clipped and then ground whole through a fine meat cutter three times, bones and all. This ground fish is then mixed with dried buttermilk until all the moisture from the fish has been absorbed. If properly mixed, which is a necessity, it will keep without ice almost forever. This mixture is made into balls the size of a baseball and it gets as hard as a rock. When fed it is either grated through screen wire or 1/4" hardware cloth, depending on the size of the fish to be fed. We have tried ground shad but the results were not satisfactory, probably because the goldfish hold up their eggs all summer when held in the cold spring water here, and make a richer food. Liver was tried and due to my inability to smell, some spoiled liver was fed to the fish, the result being a loss of 10,000 1" fish in 10 minutes. At least I thought it was the spoiled liver that killed them and never had the courage or fish to throw away to try the experiment again.

No difficulty has been experienced in getting the fish to eat. But it is believed to be beneficial to keep them a little hungry with regular hours for feeding instead of too well fed. While they are young they are fed five times a day, when they get up to 1" three times is sufficient. It is a necessity to give the fish a salt bath every five days after they start feeding. I use ½ pint salt to 2 gallons of water and dip them for about five seconds. At the same time we clean out the trough and scrub it out with salt. If the troughs are not kept clean there will be a loss of fish, and when you lose a few it is the rule to lose most of them. Out of 175,000 fish hatched and reared to 1½" in the hatchery this season there has been a loss of 116.

Due to the fact that almost everything that lives in water large enough to do so, will prey on young catfish, it is a necessity that the lake be cleaned before it is to be stocked with fish that are from 1¼" to 1½", which is about as large as is practical to try to raise them in the troughs. We have found it more certain of success to drain the lake to be planted and let it remain dry for three days. This brings up the fact that you can harvest a crop of 1½" bass from the lake before it is needed for the catfish and get two crops of fish from one lake in one year. Refill with water through #18 mesh wire or less and let stand for a day or so, then fertilize with 100 lbs. of sheep manure and 10 pounds of phosphate per acre of water. Let the lake stand three more days and then stock with 25,000 fish per acre of water. The lakes should be fertilized every ten days with 10 lbs. sheep manure and 3 lbs. phosphate per acre of water. The fish will survive in the above numbers without feeding but it will cut down on the growth rate if they aren't fed some. I stocked a lake this season of 1.6 acres with 45,000 channels 1½" long on July 15. On October 4 the lake was drained and 45,000 fish were recovered - hand count - that were 2½"

average. A lake of .4 acres was stocked with 12,245 on June 16 that were 1¼" average. On September 21 it was drained and 12,242 were recovered that were 2½" average. A lake of .8 acres was stocked with 20,000 on June 24 and 20,000 were recovered on November 15.

No diseases have been encountered in the rearing of channel catfish at this hatchery (I'm knocking on wood), but there is more possibility where hand feeding is done on a larger scale than we practice and where the fish are stocked heavier. The most common disease is that which may be distinguished by small bumps coming under the surface of the skin. If this is encountered it can be cured by drawing the pond down for three days below the feeding area and feeding them on new surface, refilling the lake.

Without the aid of muzzles, as is needed in the rearing of bass, you can expect a very small loss in the lakes until distribution time on October 1, and although there is a wide difference in the growth rate of the fish which I cannot explain they will average a good 3" long at this date with a few up to 5" and 5½" but all well on the road to making a catchable fish.

THE FOURTH NORTH AMERICAN WILDLIFE CONFERENCE

THE FOURTH NORTH American Wildlife Conference was held under the auspices of the American Wildlife Institute February 13-15, 1939 in Detroit, Michigan. The technical session on fish management consisted of a morning and an afternoon meeting held on the first day of the conference. Dr. Carl L. Hubbs, Curator of Fishes of the Museum of Zoology of the University of Michigan, was chairman in the morning followed by Dr. Albert S. Hazzard, Director of the Michigan Institute for Fisheries Research, as chairman in the afternoon. Both sessions were fairly well attended by technicians, administrators and sportsmen from several states.

As might be expected from the location of the meetings, Michigan contributed most heavily to the program, six of the twelve papers coming from this state. However, the small number of papers offered when compared with the number on the game programs (61) and the relatively small attendance by fish technicians raises a serious question as to the need for two international fisheries conferences.

The need for more critical analysis of the value of present fish management practices such as artificial propagation and predator control and the promise of new methods for increasing the fish crop were the ideas which dominated both sessions. Emphasis throughout was laid on population studies. The value of catch records and tagging in solving controversial problems also came in for considerable discussion. The effects of dams both upon migratory fishes in the west and upon fish production in eastern waters was considered from several aspects in a number of papers and in

the discussions which followed. Methods used in fisheries research were reviewed and were questioned--a healthy sign.

Creation of better fishing through population control was emphasized by two of the papers given. It seemed to be the concensus of opinion of the group that the greatest need at present is for the establishment of test streams and lakes where present methods of fish management can be subjected to critical and intensive investigation, so that new methods can be evolved and tested.

Through the courtesy of Mr. C. M. Palmer of the Institute, copies of the papers presented at the two technical sessions on fish management were made available for review. The PROGRESSIVE FISH CULTURIST takes pleasure in presenting herewith a selected series of abstracts (prepared by R. L. Carson of the Bureau's staff) prior to publication of the full proceedings of the conference.

ABSTRACTS OF SELECTED PAPERS FROM THE FOURTH NORTH AMERICAN WILDLIFE CONFERENCE

NATURAL PROPAGATION VERSUS ARTIFICIAL PROPAGATION IN RELATION TO ANGLING

By P. R. Needham, Associate Aquatic Biologist, U. S. Bureau of Fisheries

In management of fresh water game fishes, each water presents its own problems and facts on each must be obtained before any sound basis for stocking or other improvement can be devised. Heavily fished streams of limited carrying capacity may require the planting of legal size trout, while in wild, inaccessible waters which are but little fished natural propagation usually carries the load successfully. Fact finding to determine whether hatchery fish should be planted and whether good use is being made of hatchery products pays in dollars and cents. The most helpful type of fact finding is measurement of fish crops by planting marked fish to determine how much natural propagation is contributing and what percentage of the various sizes of hatchery fish planted survive to enter angler catches.

Examples of catch records obtained on several national forests illustrate the need for further and more detailed studies. In Squaw Creek in the Shasta National Forest 10,000 eastern brook, 120,000 rainbow, and 140,000 Loch Leven trout were planted between 1932 and 1936. Records for the 1937 season show a total of 337 catches, amounting to 2,504 trout. Of these 2,497 were rainbow and 7 were Loch Leven trout. No eastern brook trout were reported caught. Even the low survival ratio indicated by these figures may be too high, for at least some of the fish caught must have been naturally propagated.

Catch records for 1937 on Fish Lake in the Umpqua National Forest in Oregon gave a total of 5,946 trout reported caught. Of these 5,878 were native rainbow and only 68 were introduced eastern brook trout. The only recent planting of rainbow trout was in 1937 and these fish could not have entered anglers' catches the same year. Twenty thousand brook trout were planted in each of the years 1935 and 1936. If the ratio of fish planted to fish caught be based only on the 1935 plant, the ratio is 1:294. Additional data are required to show actual survival rates, but the figures available show that natural propagation is largely responsible for the excellent angling in Fish Lake.

Actual returns must be determined by planting marked hatchery fish and recording the number caught by anglers. Only such information carefully obtained in selected waters over a period of years will permit a determination of the true value of hatchery fish as compared with the numbers supplied by natural propagation.

R. L. C.

SUCCESS OF PLANTINGS OF FINGERLING TROUT IN MICHIGAN WATERS AS DEMONSTRATED BY MARKING EXPERIMENTS AND CREEL CENSUSES

By David S. Shetter, Institute for Fisheries Research
Michigan Department of Conservation, Ann Arbor, Mich.

In experiments conducted in various Michigan waters to determine the survival rate of hatchery reared fingerling trout in natural waters, no returns of legal fish were received which exceeded 1.6 percent of the total number of fingerlings planted. Returns from 3 out of 6 lots of marked brook trout fingerlings amounted to 0.03 percent, 0.60 percent, and 1.60 percent of the trout planted. Returns were obtained from two of the three releases of marked rainbow trout fingerlings, the percentage of survival being 0.02 percent and 1.07 percent. No returns were reported for any of the marked brown trout fingerlings.

Two sources of possible error are recognized: The possibility of mass migration of marked fingerlings away from the areas of release, or the failure of anglers and creel census clerks to recognize the marked fish. However, previous tagging and experiments by the author demonstrated that the brook trout population is relatively sedentary in at least one of the streams where the fish were released. Owing to the widespread publicity the work received, it is not believed that any significant number of the marked fish caught were unreported.

The results of these experiments and of others by workers in West Virginia and Oregon are interpreted as showing that the planting of fingerling trout in the waters studied to date has resulted in a negligible return to the fishermen. More widespread use of the "test stream", as operated in Vermont, Pennsylvania, and West Virginia, is advocated to provide more accurate acknowledge of the percentage of planted trout fingerlings that survive to the angler's creel.

R. L. C.

COMMENTS ON THE ADEQUACY OF ACCEPTED STREAM BOTTOM SAMPLING TECHNIQUE

By Justin W. Leonard, Institute for Fisheries Research
Michigan Department of Conservation and University of Michigan

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The accuracy of the collapsible brass-frame sampler was tested by repeated sampling of three restricted, uniform areas. The results show that as regards total volume of food organisms present, considerable reliance can be placed on results derived from a single carefully handled sample. It is also evident, however, that although repeated sampling of a uniform bottom type within a restricted area yields very similar volumetric values, the faunistic elements making up these values vary greatly in species composition. It is suggested that a given area of stream bottom is capable of sustaining a definite amount of insect life, which may be composed of any combination of a variety of species suited to the habitat. A single sample, therefore, does not necessarily provide a comprehensive picture of the relative numbers of individual species throughout the larger areas from which the sample is taken.

Among problems needing attention, the true position occupied by each species in the food cycle of game fishes is mentioned.

By measuring specimens in the field immediately after being killed and again after 15 months of preservation in 73 percent alcohol, it was found that a large amount of shrinkage occurs. Application of a correction factor is urged when comparing preserved samples with those measured while fresh.

Although the collapsible bottom sampler is considered the most satisfactory device available for studying supplies of fish food organisms, certain limitations of the method are described. Among these are the difficulty of operating the sampler at very low temperatures and of seating the net in rough gravel or rubble, the comparative uselessness of the net in quiet water sections of streams, and the time required to sort out the organisms.

R. L. C.

FISH MANAGEMENT IN SMALL ARTIFICIAL LAKES

By David H. Thompson and George W. Bennett
Illinois Natural History Survey, Urbana, Ill.

The artificial lake management program fostered by the Illinois Natural History Survey is concerned with the problems of (1) lake construction, (2) erosion control to keep these lakes from filling with silt and to keep their water clear, and (3) fish management to give satisfactory yields of the more desirable hook-and-line fish.

An artificial lake should be located where the drainage area is large enough to prevent the water level from dropping more than a foot or two below the spillway during drouths. The most successful and inexpensive lakes are those which have 10 to 50 acres of drainage for each acre of water, and the most desirable size for the lake itself is between 10 and 50 acres. Most lakes of this size vary in depth from 5 to 20 feet above the dam.

Erosion control on the watershed is an essential part of the management of artificial lakes. The same farm practices which conserve soil will prevent lakes from filling with silt and help keep them clear. In addition to other obvious advantages, clear water is essential for lake fish which are sought by hook-and-line fishermen, such as bass, crappies, and bluegills. It speeds up their growth and also makes them bite better because these fish feed by sight. Watershed soils of finely divided clay will retard the clearing of lake waters. It has been found that carp, buffalo, suckers, catfish, and the usual fish put in as forage stir up the mud on lake bottoms and keep the water roily.

Four kinds of desirable hook-and-line fish are adapted to small artificial lakes in Illinois: Largemouth bass, bluegill, white crappie, and the black bullhead.

Censuses on seven small artificial lakes in Illinois show that these bodies of water support a large poundage of fish. The total number of pounds of fish per acre which these lakes were supporting varied from 232 to 1143. Production of game fish (largemouth bass) ran from 3 to 49 pounds; of fine fish (crappies, bluegills, etc.) from 6 to 183 pounds. Variations in the total poundages are attributed to differences in the relative numbers of the common species. In general, increasing proportions of bass, crappies, and bluegills gave decreasing total poundages. It is considered probable that the usual forage fishes - especially gizzard shad and golden shiner - do more harm than good by roiling the water and competing with the hook and line species for food. The largemouth bass - bluegill combination is believed to be particularly good. The bass feed on young bluegills while the bluegills feed on vegetation and animal life too small for bass.

Collection of data on each individual lake is urged as a basis for its proper management. Instructions for collecting pertinent data are given.

R. L. C.

INCREASING FISH PRODUCTION IN POUNDS

By H. S. Swingle and E. V. Smith
Alabama Agricultural Experiment Station, Auburn, Alabama

Methods of increasing fish production in ponds were investigated at the Alabama Agricultural Experimental Station in a series of experiments begun in 1934. Ponds were stocked with known numbers of fish, which were again counted and weighed at the completion of each experiment. Tests were made of the effect on fish production of various rates of stocking, of the size of fish used in stocking, and of increasing the natural food in the ponds.

Regardless of differences in the rates of stocking varying as much as from 236 to 4,485 fish per year, the production of bluegill bream in unfertilized ponds remained approximately 100 pounds per acre. These results furnish evidence that a given pond can support only a given weight of fish per acre, and that fish production (measured in pounds per acre) cannot be increased by the addition of more fish of the same species to the pond. On the contrary, unless the food supply was increased at the same time, the addition of more fish to a pond decreased the average size of the fish when those added were able to survive.

Stocking with large fingerlings gave no better results than stocking with smaller fish, except in the case of overstocked ponds. The number of pounds of fish present at the end of the experiment was proportional to the food produced in the pond, regardless of the size of fish used in stocking.

These results are cited as evidence that the main problem in increasing fish production is that of increasing food. Tests in the ponds at Auburn showed that fish production increased as the amount of plankton in the water increased. Further experiments showed that the amount of plankton could be increased by the use of commercial fertilizers. The most efficient mixture for increasing fish food was the following: 40 pounds sulfate of ammonia, 60 pounds acid phosphate (16 percent), 5

pounds muriate of potash, and 15 pounds finely ground limestone or 30 pounds basic slag. These amounts of fertilizer were used for each acre of pond at each application. Best results were obtained by mixing the materials just before they were used. Ten to 14 applications per year gave maximum production. Unfertilized acre ponds yielded 140 pounds of fish, while heavily fertilized ponds yielded 580 pounds in one year. The cost for fertilizer varied from 3 to 6 cents per pound of fish produced.

R. L. C.

OBSERVATIONS OF THE SPAWNING HABITS ON CENTRARCHID FISHES IN DEEP LAKE, OAKLAND COUNTY, MICHIGAN

By W. F. Carbine, Institute for Fisheries Research
Michigan Department of Conservation, Ann Arbor, Michigan

This paper presents observations on the spawning habits and the number of fry produced per nest by the bluegill (Lepomis macrochirus), the common sunfish (Lepomis gibbosus), the rock bass (Ambloplites rupestris), and the largemouth bass (Huro salmoides).

Certain individuals of the species studied constructed well defined nests while others did not. Fish of one species sometimes appropriated nests built by individuals of another species. For example, rock bass used sunfish and largemouth bass nests; largemouth bass used rock bass nests; common sunfish appropriated the nests of bluegills, and vice versa. It appears probable that the nests were pre-empted only when the original owner had finished spawning and fry and adults had left. Individual nests of bluegill and common sunfish were sometimes used several times during one season, either by the same or different fish, to produce successive broods of fry.

Data are given on the character and location of the nests of the four species studied, based on observations of 33 largemouth bass nests, 58 rock bass nests, 188 common sunfish nests, and 369 bluegill nests. The number of fry per nest was determined by collection and actual count of the young from as many of the nests as possible.

A considerable variety of bottom materials was used for nest construction by all species. Nests were found in from 1 to 5 feet of water, a shallower depth than has been found in many other waters. The degree of slope of the bottom is believed to be the factor limiting the de h of the nests. Nests of the largemouth and

rock basses were inconspicuous and usually occurred singly; those of the common and bluegill sunfishes were well defined and usually occurred in colonies. Apparently neither species of bass uses the same nest twice during one season; while the sunfishes may use their own nests several times.

Considerable variation was noted in the number of fry counted from individual nests. It is believed that the counts of largemouth bass and common sunfish fry are not as representative as fry counts for the other species, because based on fewer nests.

The number of bluegill fry per nest varied from 4,670 to 61,815 (probably indicating that more than one female spawned in some nests) with an average of 17,914 in the 17 nests counted. The average number of fry per nest for common sunfish was 8,074; for rock bass 796; for largemouth bass 4,977.

The minimum production of fry in Deep Lake was estimated to be 6,610,000 for the bluegill; 1,518,000 for the common sunfish; 46,000 for the rock bass; and 164,000 for the largemouth bass. These figures were obtained by multiplying the average number per nest by the total number of nests observed. Data on rock bass, common sunfish, and largemouth bass are conceded to be inadequate and are included merely for comparison with bluegill data.

R. L. C.

A COMPARISON OF SUMMER AND WINTER FISHING IN A "BLUEGILL LAKE"

By Albert S. Hazzard and O. H. Clark, Institute for Fisheries Research,
Michigan Department of Conservation)

An intensive creel census conducted on Bear Lake, Hillsdale County, to determine the relative numbers of fish taken in winter and in summer indicated that winter fishing on this lake and two connecting lakes had no detrimental effect upon fishing during the following summer. This study was undertaken to supply information on one of the so-called "bluegill lakes" along the southern border of Michigan. Its results are in agreement with similar surveys on northern lakes which indicated that winter fishing could not be held responsible for any serious decline in summer fishing.

The creel census was started shortly after the ice formed in the fall of 1937, extended through the winter to the close of the open season in the spring of 1938, and was resumed from June 25th to October 1st of that year. It is believed that records were secured of approximately 95 percent of the fishing on Bear Lake.

During the winter only 238 fish were taken by 311 fishermen. Census during t e summer proved that the fish were there even though they did not bite as a total of 8,301 fish were reported taken by 3,342 anglers from June 25 to October first. More fish were taken on one of the summer's best days than were caught during the entire winter.

The catch per fisherman hour in winter was 0.3; the rate for summer fishing was twice as good. Seventy-seven percent of the winter fishermen took no legal size fish; in summer 38 percent failed to score. The number of legal sized fish taken per acre was 2.03 in winter as compared with 79.8 in summer.

No correlation could be discovered between the quality of the fishing and water temperature, air temperature, wind direction, or wind velocity.

Analysis of partial data from the two connecting lakes, Pike and Fowler, tends to confirm results secured on Bear Lake.

R. L. C.

COMMENTS FROM OUR READERS

STERILIZING PONDS

EDITOR, THE PROGRESSIVE FISH CULTURIST:

Through the courtesy of Dr. Davis I was privileged to observe the sterilization of York Pond by means of liquid chlorine as described in the Nov.-Dec. 1938 issue of the P. F. C.

It has been an established policy at several of our New Hampshire hatcheries for the past few years to sterilize by means of permanganate or HTH our pools and race-ways whenever they are newly stocked with fish. The simplicity, speed, and low cost of liquid chlorine sterilization so impressed me that we experimented with this method during the fall and worked out several refinements of technique which I believe are worth passing on to fish culturists in general.

When, as Dr. Davis indicates, liquid chlorine is released from the pressure within the cylinder it immediately enters the gaseous state. When introduced into water of even considerable depth the large size of the bubbles, with low ratio of surface to volume, results in loss of chlorine at the surface of the water with consequent discomfort to the operator and waste of money. While a finely perforated

nozzle on the hose helps some and insertion of the hose into the supply main helps more, these are far from satisfactory solutions of the problem.

It remained for Messrs. Hubbard and Butler of the New Hampshire State Hatchery at New Hampton, N. H. to solve the difficulty and greatly extend the usefulness of liquid chlorine in hatchery work. By clamping an outboard motor to a plank, setting the plank across a pool so that the propeller ran as deep as conveniently possible, and directing the chlorine gas against the propeller by means of common garden hose the large bubbles were broken up into thousands of little ones which went into solution before reaching the surface.

The advantages were numerous. As the water was vigorously circulated in the pool the amount of water entering at the intake assumes no importance in so far as the rate of introduction of chlorine is concerned. The rate of release of chlorine permitted by this procedure practically eliminates the troublesome freezing up of the cylinder release valve. Speed was greatly increased, six thousand cubic feet of water could be raised to 10 ppm of chlorine within fifteen or twenty minutes.

During the summer we also found that high test soda bleach, obtainable from the Brown Co., Berlin, N. H., coming as it does in liquid form was a more convenient source of chlorine for the treatment of disease than either gas or HTH. The chief advantage being that it can be measured in a graduate, which all hatcheries seem to have, and eliminates the need of delicate scales, which hatcheries never seem to have.

We also discovered that chlorine was not satisfactory for sterilization of our tank trucks as the valve springs in the pump would be eaten away very rapidly. Therefore we continue to use permanganate in the sterilization of our trucks, pending the development of non-corrosive valve springs.

While chlorine had no ill effects upon the outboard motor, our experience with the valve springs leads me to caution anyone trying a motor for the first time to examine it carefully at frequent intervals in order that damage to a good motor may be avoided.

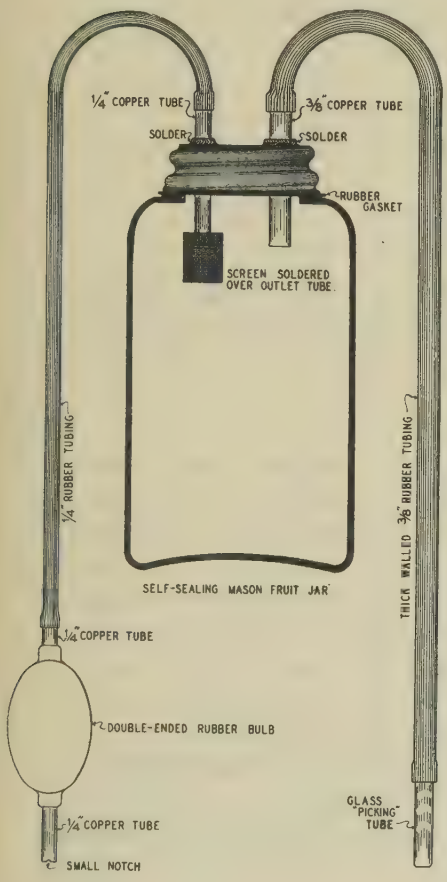
Frank H. Connell
Dartmouth College

5879

SYPHON EGG PICK

EDITOR, THE PROGRESSIVE FISH CULTURIST:

Your advice some time ago, to any of us using gadgets of our invention, was to send them in. I am sending in a drawing of an egg pick I have been using for several years that has the good points of both the bulb and the syphon.



This egg pick is made from a Mason fruit jar with a self-sealing lid. This lid is used so that if the sealing compound is spoiled in soldering, a small rubber ring may be used in its place, as the jar must be air-tight.

Two short copper tubes about 3 inches long are soldered into the jar lid, one an ordinary 1/4 inch. The other has to be 3/8 inch to keep the eggs from plugging it. The rubber tube for the pick side has to be fairly heavy to keep it from collapsing, and 3/8 inch. There is a syphon tube sold in most hardware stores that is about right. Syringe tubing is too small for this tube, but is all right for the other one. These should be about two feet long.

The bulb is an atomizer bulb and can be had at any drugstore. The valve is removed and two small 1/4 inch copper tubes are inserted in the ends. The glass tube is any picking tube, though it may have to be fastened into the 3/8 rubber tube with tire tape. A small screen may be soldered over the outlet pipe inside the jar to prevent the eggs from being sucked into it.

A wire can be twisted around the neck of the jar and a hook made to hang the pick on the side of the trough.

The copper tube coming out of the bottom of the bulb should have a very small notch filed across the lower end (not over 1/16 inch).

To use this pick, fill the jar with water and screw the cover down tight. Place the glass tube in the water between the baskets. Take the bulb in the palm of the left hand with the second finger over the end of the copper tube. By squeezing the bulb and then tightening the finger on the tube and releasing the bulb and repeating this a time or two, the syphon can be started and controlled by the finger on the tube.

Any good eggs can be ejected by pressing on the bulb. The small notch in the copper tube makes it easier to regulate the syphon. The eggs will stay in the jar.

A. C. Playfair
Chewelah, Washington

NOTES AND NEWS

GEORGE C. EMBODY

Fisheries workers, conservationists, and sportsmen were shocked to learn of the passing of Dr. George C. Embody in Florida on February 17. He had gone South with Mrs. Embody for a rest and was stricken at Daytona Beach. This is an irreparable loss to science, colleagues, and friends.

Dr. Embody was born in Auburn, N. Y., on November 23, 1876. He attended Colgate College, graduating with a bachelor's degree in 1900 and receiving his master's degree in 1901. For his leadership and accomplishments in his chosen field Colgate awarded him an honorary degree of Doctor of Science in 1924. He pursued his graduate work at Johns Hopkins University in 1906 and 1907, and took his doctorate at Cornell University in 1910, after several years of teaching. In the fall of 1911 he started teaching aquiculture at Cornell, where he remained until the time of his death. Although originally intending to be a physicist, his love of nature, especially of field work, and of both fishing and hunting, led him into the then unsounded field of fisheries management. His contributions for the improvement of practical hatchery technique and planting procedures were the first to be developed. He originated the first planting table on trout showing the numbers of fish that should be planted in relation to food, shelter, and other stream conditions. His first stream survey in Tompkins County, N. Y., in 1918-1919, was later published by the New York State Conservation Department in 1922.

Dr. Embody's paper on trout feeding experiments in the December, 1918, issue of the Transactions of the American Fisheries Society was awarded first place for original work in fish culture. In 1924 he served as president of this society.

He started the first strictly experimental fish hatchery on Cascadilla Creek on the Cornell campus, where he developed many of the modern fish cultural practices. His constant aim was to improve hatchery technique. New York and New Jersey

conservation departments consulted him repeatedly; other states sought his advice; commercial and private hatcheries confronted him with their problems; tropical fish enthusiasts and sport fishermen received his advice; in short, his advice was always available regardless of station.

Dr. Embody had two books about ready for publication when he died: A manual of goldfish culture and one on general fish culture, with special reference to trout. His son, Daniel R. Embody, plans to complete these and other manuscripts that were about ready for publication. Since Dr. Embody was in reality the Dean of American Fish Culturists, the publication of his unfinished papers and books will be eagerly awaited. The high character and originality of his contributions pioneered many of the inland stream and lake management methods in use today.

Dr. Embody will be remembered as much for his personal qualities as for his contributions to fisheries science. As a friend and counselor, as well as a teacher, he inspired students with confidence and enthusiasm. His serenity of spirit under all conditions and difficulties was amazing to those of us who had the privilege of working under him. In all of his relationships with people there was nothing but praise for him. His funeral at Sage Chapel on the Cornell campus in Ithaca exemplified his wide range of friendships. The chapel was filled with persons in all walks of life who had come to mourn his passing and to honor him.

Paul R. Needham
U. S. Bureau of Fisheries
Stanford University, Calif.

WILLIAM M. KEIL

Very soon after receiving the "Report on Pisgah Fish Management, 1939" published in this issue, Mr. William M. Keil's many friends in Washington were shocked at the news of his sudden death from cerebral hemorrhage on January 4, 1939, in Asheville, N. C.

For several years Mr. Keil was employed on fishery management projects by the U. S. Forest Service giving particular attention to these problems in the Pisgah National Forest. This was a cooperative project between the Forest Service and the Bureau of Fisheries and ambitious plans had been made for the development of a model management project under his immediate supervision with the assistance of investigative and fish cultural personnel of the Bureau.

Mr. Keil was widely known among fish culturists of the country serving for several years as Fish Commissioner in the State of Idaho and later performing excellent services in this field for the Tuxedo Club in New York. During 1934 and 1935 he was employed by the Bureau of Fisheries as a stream improvement supervisor in its elaborate program of stream survey and stream management as a P.W.A. project in several of the national forests in the southern Appalachian region.

His broad knowledge of fish culture and management is evidenced by numerous articles published in THE PROGRESSIVE FISH CULTURIST and elsewhere during these years which include "Better Stocking Methods", No. 9, August, 1935; "Care of Fingerling Trout and Salmon", No. 18, May, 1936; "Spawn-taking Operations", No. 22, September, 1936; "Selecting and Developing the Brood Stock of Trout", No. 25, December, 1936; "Fish Management in the Pisgah National Game Preserve", No. 35, January, 1938; "Developing Trout and Salmon Fishing in Lakes", No. 41, October, 1938; and other minor contributions.

Mr. Keil's writings reveal painstaking care and consideration of the many details of successful operation without losing sight of the fundamental aims and purposes of conservation work. His technical knowledge and ripe practical judgment have enriched the literature of fish culture in the United States and it is with a sense of irreparable loss that THE PROGRESSIVE FISH CULTURIST presents in this issue the last of his contributions to the art.

EARL E. HOOVER

(Reprinted from SCIENCE, N. S. Vol. 89, No. 2309, March 31, 1939)

EARL E. HOOVER, biologist of the New Hampshire State Department of Fish and Game, died at Concord on January 8, after an acute illness of several weeks. Of all the younger workers he showed perhaps the greatest promise of leadership in the impending development of the science and art of freshwater fish management. Three annual survey reports, the last of which was only recently published, stand as tributes to his energy and competence. He made worth-while contributions to herpetology as well as ichthyology and fisheries science, and was engaged in a brilliant and pioneering research dealing with the effect of altered periods of daylight on the time of reproduction in fishes. An investigation of dwarfing in trout, from the systematic and evolutionary as well as fisheries viewpoint, was well under way and was to have been utilized for a doctorate dissertation at the University of Michigan.

Hoover was born at Somerset, Pennsylvania, on December 5, 1911. His undergraduate studies were carried on at Lebanon Valley College, and graduate work was done at the Johns Hopkins University, where he served as instructor in 1934-35. Before assuming the position in New Hampshire in 1936, he worked one year as field zoologist in the National Park Service. Despite a tragically short career, Earl Hoover made many friends and a very real impression in several fields of scientific endeavor.

CARL L. HUBBS

FISHERIES ADMINISTRATION

By George E. Sprecher, Asst. Supt. of Fisheries
Wisconsin Conservation Department, Madison, Wisconsin

(Reprinted, with permission, from Wisconson FISHERIES
BIOLOGICAL BULLETIN, Dec. 12, 1938, No. 12)

THE PURPOSE of this article is to clarify and describe the administrative procedure involved in conducting the business of fish propagation in Wisconsin.

After sixty years of slow, gradual growth, the fisheries division suddenly found itself in the ranks of big business. Fish production in Wisconsin is indeed a big business! When an organization expends over a quarter of a million dollars per annum and produces a billion fish in the same period, it is automatically placed in the same category as a trust, holding company, or large corporation.

In 1937, the output of the fisheries division doubled that of any previous year. This tremendous increase showed clearly that modern methods of conducting business would have to be injected into this division without delay. It was very evident that one man could not, by any stretch of the imagination, efficiently carry out all of the administrative details connected with work which concerns itself with all of the waters in the state of Wisconsin. Director MacKenzie, therefore, appointed three area supervisors to administer all of the various activities of the fisheries division in their respective designated areas. These supervisors are directly responsible to the superintendent of fisheries and his assistant. Three area dispatchers were also appointed to maintain records and manage area offices. Hatchery foremen are able to obtain immediate information and instructions regarding their activities direct from the area supervisor. Group purchases within the area result in large savings. Transfer of personnel, in emergencies, is very valuable in the conduct of fisheries work. Transfer of equipment and materials renders the work flexible and speeds up operations.

Fish propagation is of such a nature that rapid communications are essential. Spawning, rescue, transfer, flood damage, and many other items must be attended to on short notice. A heavy concentration of materials and equipment is held in readiness for such work at area headquarters. Repair shops are established to repair and remodel trucks, pumps, motors, nets, and other equipment. Regular inspection of these items reduces the cost of operation.

Coordination of the duties of the field officers of this division are noteworthy. Area supervisors are called into conference at various intervals and new problems and policies are outlined for the entire division. Meetings called by area supervisors

are attended by hatchery foremen, fish culturists, spawners, and other employees within the area to discuss uniform methods of fish propagation and distribution. Accurate records showing the quality and quantity of work accomplished by each employee are kept and used as the basis of promotions within the division.

Budget allotments are made by the comptroller at the beginning of the fiscal year for all hatcheries and areas. The area supervisor is responsible for operating his area within the budget allotted to him. Hatchery foremen are likewise responsible for economical operation of their hatcheries and must not incur a deficit. In the event a hatchery foreman needs more funds, he must consult his area supervisor, who in turn must determine if funds are available and can be transferred from some other source. Such transfer of funds must be submitted to the comptroller for his approval.

The biology division, whose main function is to conduct research, is the most important unit operating in cooperation with the fisheries division. It is called upon to investigate proposed hatchery sites, pollution problems, disease control and conditions, and all other problems involving scientific study. An area biologist is stationed at the area headquarters and renders assistance to all hatcheries in the area. Hatchery foremen may call on him for instructions in disease control, feeding rations, sanitation, and other matters concerning his operations. Daily reports are submitted to the area biologist indicating the condition of fish in the hatchery. One bacteriologist, stationed at Madison, is available to the fisheries division for special problems of disease and sanitation. He may be called upon to render assistance in any part of the state.

Each trout hatchery is under the direct supervision of a hatchery foreman. The foreman is responsible for efficient and economical operation of his hatchery. The hatchery must be kept clean at all times. Equipment and buildings must be kept in good repair. Employees must be given every possible opportunity to improve their knowledge of fisheries operations. The hatchery foreman constantly meets the public and he must, therefore, keep himself informed on all conservation matters. He must be courteous and offer every reasonable consideration to the traveling public. Above all, he is required to keep accurate records of his operations. Such records are the most important factors in improving the standard of fisheries operations.

During spring spawning operations, a number of men are appointed as temporary hatchery foremen. These men assume the same responsibilities that a regular foreman assumes throughout the year. It is important that the temporary foreman observe carefully the efficiency of the spawners and helpers under his supervision. As a rule these men are employed on a temporary basis and only those who show unusual care in the handling of fish, eggs, and equipment, are placed on the regular payroll.

Alert, intelligent, and industrious employees are the most important part of the fisheries division. These men come in daily contact with problems of fish culture and their ability to properly handle delicate emergency conditions has resulted in Wisconsin's unprecedented billion fish program.

In order that no employee of the fisheries division may be uninformed of proper procedure with relation to his duties, a fisheries manual has been prepared. One of these manuals has been issued to each hatchery foreman and all employees at his

station are urged to study it. The manual is not to be removed from the hatchery nor is it to be loaned to the general public. New methods are incorporated in it each year and at that time all copies are forwarded to Madison for revision.

Employees are encouraged to discover new and economical methods of fish culture. They frequently report possibilities some of which have ripened into very valuable parts of the fisheries program. Muskellunge culture, artificial spawning and rearing of black bass, and panfish culture are some of the practices which have grown from small beginnings.

Wisconsin proposes to continue its growth in fish propagation and distribution and to do it in a well-organized, businesslike way.

THE MERGANSER--TROUT FANCIER*

By J. Clark Salyer, II, and Karl F. Lagler

(Reprinted, with permission, from AMERICAN WILDLIFE, Jan.-Feb. 1939)

THE HOODED MERGANSER

STUDIES ON the winter food and feeding habits of the American Merganser in Michigan give a startling picture at times. This bird is almost entirely piscivorous and examination of stomach and gullet contents show it to be voracious indeed.

The usual feeding grounds of the large migration concentrations and of the smaller wintering populations of the American Merganser in Michigan are the Great Lakes bays and river-mouth lakes. Wintering birds on larger southern rivers, such as the Kalamazoo and the Huron, eat large numbers of coarse fish. On the Kalamazoo, thirteen individuals contained the remains of 316 carp ranging between four and six inches in length. Except in the salmon country the food habits of this merganser on coastal waters (marine), as well as those from most Great Lakes bays and rivermouth areas are essentially similar, likewise showing a preponderance of rough fish in the diet. In such regions mergansers are doubtless of little significance to sport or commercial fisheries.

*Contribution from the Cooperative Fish Management United of the American Wildlife Institute (with support from the Associated Fishing Tackle Manufacturers), the Institute for Fisheries Research of the Michigan Department of Conservation, and the University of Michigan.

When unusually prolonged cold weather causes the bays and rivermouth lakes to remain frozen well into the mergansers' early spring migration period, the birds are forced upstream onto the more productive troutwater sections of the larger tributary rivers which remain open. At such times, apparent cause for concern over the success of trout fishing during the following season is realized. Analyses of the stomach contents of 157 American Mergansers from Michigan trout streams give the following results:

(1) The average number of trout per stomach examined is approximately 2.5.

(2) A conservatively estimated average of the number of trout eaten per day per bird is five.

(3) The average length of trout eaten is 5.8 inches based on 327 trout from the 157 stomachs.

(4) The average length of 241 sub-legal trout is 4.5 inches; that of 86 keepers, 9.4 inches. 1/

(5) A fair estimate of the daily food requirements per bird, based on field observations and stomach analyses, is considered by us to be about 1.5 pounds or about 1/2 to 2/3 of the body weight.

(6) Failure of abundant forage organisms, of average smaller size than the average size of the trout taken, to buffer the trout population leads to the conclusion that the American Merganser selects its food with a preference for larger items. This conclusion is further confirmed by our findings on several non-trout streams and on the larger southern rivers already discussed, which have even a richer fauna of smaller buffer organisms than have trout streams. Field observations also indicate that the American Merganser feeds largely by sight.

(7) Many of the larger rivers in southern Michigan have too large a population of small sunfishes of several species. Such fish constitute by far the largest group of food items found in the diet of mergansers on these streams. It is apparent that the food habits of this bird on this type of water are wholly innocuous and may even be beneficial in reducing the competition which produces stunting among these fishes. Fewer, but larger, fish may result.

That mergansers feeding on trout streams may be responsible for the depletion of the legal trout population to a point where sport fishing cannot yield desired results is very possible. Suppose that a flock of one hundred American Mergansers were to concentrate for a fortnight, as they have been observed to do during the last part of a prolonged winter like that of 1933-34, on a typical mile long section of the famous North Branch of the Au Sable River in northern Michigan. Our food studies show that they would take daily about five hundred trout-seven thousand in the fortnight averaging a little under six inches in length. Of the seven thousand trout,

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1/ Legal size-limit in Michigan is 7 inches.

36% or 2,520 would probably be legal fish averaging over nine inches in length. This is a stupendous number but doubtless well within the realm of possibility under the rare climatic conditions stated. Such a series of events might well be an important fator in accounting for the failure of fisheries workers to recover but a few of several thousand jaw-tagged trout released in this stream.

When such dangerous concentration of mergansers occur, some form of protection against their depredations is obviously needed. The method which we recommend and which has been adopted in Michigan was originated by Salyer in 1935. When as many as twenty-five American Mergansers are encountered on any one mile of troutstream, control is inaugurated under the direct supervision of technically qualified individuals. Patrols on both sides of the stream work downstream simultaneously in an effort to drive the birds before them to the lowest open waters. In these lower waters, trout are usually fewer in proportion to other fish and damages by the fish duck are less extensive and less significant. The experience of the authors also has been that repeated drives of this nature tend to break up heavy concentrations and to disperse the birds and relieve their pressure on local trout populations. Repeated drives tend to cause the mergansers to retire in smaller groups to open waters of other streams.

On rare occasions fish ducks raid valuable fish in rearing waters. Such raids are to be expected, for fish in rearing ponds almost literally bait fish predators. In the spring of 1934, a flock of mergansers took between three and four hundred trout, between eight and ten inches long, from a commercial hatchery near Traverse City, Mich. In 1936 another flock alighted on a pond of Montana grayling at Wolf Lake State Hatchery near Kalamazoo, Mich. All of several hundred grayling from ten to fourteen inches long, as well as thirty-five albino trout, were missing when the ducks departed. The operator of a private fish hatchery near Highland, Mich., has had a similar experience. During winter months, protection should be afforded such fish by means of frightening or excluding devices in order to assure success in production. Cross-wires and poultry netting at ground level on small rearing ponds and raceways have both been effectively used to exclude fish-eating birds in Michigan.

TROUT STOCKING

By C. A. French
Pennsylvania Commissioner of Fisheries

IN PROVIDING angling for trout under present-day conditions, it is largely a business of restoring the crop after each annual harvest, and replanting the areas with large-sized fish. From the business angle of aquatic conservation, the fishermen should be familiar with what is required to annually reseed the trout waters of

Pennsylvania, and when a tank load of big trout is planted in your favorite stream, impress upon others that they represent a cash value, paid for by all licensed anglers. Another vital point of business in the annual trout distribution program is to discourage the ever constant demands to plant this valuable crop in undesirable waters, and to discourage the over-stocking of second and third class streams. In other words the planting of trout in a stream over and above the carrying capacity is poor business and a waste of your investment.

During the calendar year 1938 the Board of Fish Commissioners stocked in the waters of Pennsylvania approximately 174 tons of brook trout, brown trout and rainbow trout. Most of the fish were grown at the Corry, Reynoldsdale, Huntsdale and Bellefonte Hatcheries. The cost of producing agricultural crops varies considerably in different localities, likewise the amount of food required and the cost to grow a pound of trout varies to some extent at the different hatcheries. This difference is due partly to the temperature and chemical analysis of the waters used, and possibly other factors which the Board, to date, has not been able to determine. Following is the record for the various hatcheries for 1937. (The report for 1938 is not as yet entirely completed).

Hatchery	Cost of Production	Cost Per Lb. of Trout	Food Required to Produce 1 Lb. of Trout
Bellefonte	$87,105.77	.592	4.06 lb.
Corry	26,875.55	.673	3.99 lb.
Huntsdale	18,692.06	.379	2.13 lb.
Reynoldsdale	34,498.37	.495	4.18 lb.

It required an average of 3.59 pounds of food to produce a pound at an average cost of approximately 53¢ per pound for trout planted in the streams. The cost represents all expenditures in connection with the operation of the hatcheries including supervision, distribution and maintenance, excepting interest on investment and new construction. It must also be taken into consideration that the Board of Fish Commissioners pays no tax on its properties.

Possibly a one year record of the cost of producing trout at a hatchery is not entirely fair to the institution, as the cost per pound at the same plant varies considerably from year to year. For example, there is listed below the record of the Bellefonte hatchery over a six year period:

Year	Cost Per Lb. of Trout	Food Required to Produce 1 Lb of Trout
1933	$0.563	4.4 lb.
1934	0.499	3.4 lb.
1935	0.493	2.9 lb.
1936	0.846	5.5 lb.
1937	0.592	4.0 lb.
1938	0.48	4.5 lb.
Average	0.578	4.1 lb.

The Board of Fish Commissioners has a planting program so that this valuable crop is systematically stocked in the major approved trout waters of the State, where the fish have a chance of surviving low water periods and other unfavorable conditions.

So that the greater masses may enjoy the benefit of the restocked fish we are asking that you help to shoulder the responsibility of systematic stocking and discourage the requests for fish for questionable areas.

(Extract from the Pennsylvania Angler Vol. 8 No. 3 March, 1939)

REVIEWS

"TROUT STREAMS - CONDITIONS THAT DETERMINE THEIR PRODUCTIVITY AND SUGGESTIONS FOR STREAM AND LAKE MANAGEMENT", by Paul R. Needham, Comstock Pub. Co., Ithaca, N. Y., 1938, 233 p. 74 figs., 36 tables.

DR. PAUL R. NEEDHAM'S new book, "Trout Streams", packs more real information into one concise volume than anything that has yet appeared in this country on the subject. It is difficult to put aside until read from cover to cover yet the material will be used as a reference frequently as problems arise in the field. Written in a clear simple style it is equally readable to biologist or sportsmen.

The biological, physical and chemical characteristics of trout streams and the ecological relationships of these factors are treated comprehensively. Aquatic biologists have written similar descriptions of various types of aquatic habitats before; however, Needham doesn't stop there but goes on to relate these facts to man's activities and to point out methods of application. On the other hand, the

management and improvement idea is not spread so thin that the reader feels a straining to immediately apply every shred of factual knowledge no matter how inadequate.

Wide experience in New York and New England and even wider experience in the West have fitted Paul Needham for the task of writing on trout. Readers in the trout country of the Lake States and Ontario, though, may feel just a trifle neglected. A cosmopolitan rather than provincial viewpoint, however, characterizes the book. The author's thorough entomological background, an essential for trout stream work, is evident throughout. A realistic interpretation of the facts and the absence of "far-in-the-future" theoretical discussions increases the practical value of the book.

There are certain highlights that stand out: A well known motto is paraphrased to describe past fish cultural policy, "Millions for hatching but not one cent for investigation."

The Bonneville Dam project is not completely whitewashed since the problem of getting the young salmon down over the dam is recognized as unsolved.

The general superiority of native trout over exotics is stressed throughout.

The well illustrated account of trout stream entomology and the table of preferred foods taken by trout ought to intrigue the fly fisherman.

Productivity charts showing the poundage of bottom fauna per acre make one wonder how much the actual crop of insects produced per acre would amount to throughout the course of a year. The bottom fauna and the fish catch per acre statistics support the contention often made that the average water acre is more productive than the average land acre.

Especially interesting are the studies of the tremendous productivity of the vegetation beds and the year-round studies showing ample trout food in winter as well as summer.

The author's well balanced conception of the relative importance of predatory birds and intensity of angling as contributing causes to poor fishing is a relief after reading some of the extremist opinions.

Many will be glad to hear a good word said for circular rearing pools with their larger carrying capacity over rectangular pools. The practice of stream trapping and stripping wild trout is condemned as being a case of "robbing Peter to pay paul."

The appendix contains a fund of valuable information including stream survey suggestions, a reprint of Embody's stocking table (modified) and a discussion of trout nomenclature.

A disappointment is the apparent lack of the ecological or sociological conception of a stream population. The fact that the carrying capacity is quite fixed and definite and that there is a saturation point for trout populations is something that

needs to be hammered home to most sportsmen. Near the end of the book the statement is made that, "Any given lake will produce only so many pounds of fish per acre of water area." But that theme is not carried throughout the book and fish stocking is treated as the number one tool of management.

Of five objectives in stream surveys, the first listed is, "To determine the best species, size and numbers of fish to plant....."

The stocking table is described as applicable to heavily fished streams and that, "In the case of streams which are less intensively fished, and in which there is considerable natural propagation, the numbers given in the table should be reduced 25 to 50 percent, depending on the abundance of native trout of various sizes." Why not "reduced 25 to 100 percent?" Discussing largely inaccessible streams, the author states: "In such waters natural spawning plus annual or biennial planting of small trout will probably be sufficient to maintain the fishing for some time." In view of the recent work on natural spawning in New Zealand, the justification for planting under such conditions seems open to question.

Strangely, the only experimental work quoted - Lord's work in Vermont -indicates planting to be of minor value. In Furnace Brook in the first month of the season the catch of brook trout exceeded the total planted. Apparently there is something in this natural propagation after all - unless the catch was supplied from previous plantings instead of native trout.

Probably the author is more skeptical of the value of stocking in lightly fished streams, than these statements seem to indicate. The necessity for stocking heavily fished streams is evident and the reviewer has no quarrel with it where the demand justifies the end.

The two paragraphs on lake improvements are largely negative and contribute very little to the readers knowledge of the subject.

In connection with stream mapping a numbering system for unnamed tributaries is described which is undoubtedly useful in the states not covered by the General Land Office survey but for the rest of the states any system in addition to the sectionalized survey seems superfluous.

The scope of the book is indicated by chapter headings which include: Trout and salmon, stream conditions, trout stream animals, food selection by trout, distribution of trout foods, propagation, stocking and protection, stream and lake management. There are 74 illustrations and 36 reference tables.

Written for angler and expert alike "Trout Streams" should prove to be an indispensable book for the library of both.

W. A. Elkins
U. S. Forest Service,
Milwaukee, Wisconsin.

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(Continued from inside front cover)

APPLICATIONS for this memo, which is distributed free on regular mailing lists, should be addressed to the Commissioner of Fisheries, Washington, D. C., Contributions for publication are welcome.

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